THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK AUGUST, 1907

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Proceedings of Semi-Annual (Mid-Summer) Meeting, Milwaukee, Wis., July 18-19, 1907

"Welcome, A. S. H. & V. E.," blazing in electric lights from the city hall tower of Milwaukee, was the city's greeting to the heating engineers as they gathered in that beautiful lake city for their semi-annual meeting, July 18 and 19 last. It was a proud greeting to a proud and progressive body and brought forth a warm acknowledgement from President C. B. J. Snyder, who characterized it as an impressive and handsome recognition of the society.

President Snyder called the meeting to order for its session Thursday morning, July 18, in the Red Room of the Hotel Pfister. The following members and guests were present at this or subsequent sessions:

MEMBERS AND GUESTS.

C. B. J. Snyder, New York.
James Mackay, Chicago.
Wm. G. Snow, Boston.
W. M. Mackay, New York.
Frank K. Chew, New York.
E. F. Capron, Chicago.
Sam Kauffman, St. Louis, Mo.
J. D. Hoffman, Lafayette, Ind.
John F. Hale, Chicago.
E. J. Ryan, Danville, Ill.
L. A. Larsen, Duluth, Minn.
James A. Donnelly, New York.
James H. Davis, Chicago.
C. G. Folsom, South Bend, Ind.
J. H. Martin, Jr., Chicago.
T. J. Waters, Chicago.
Charles D. Symms, Sioux Falls, S. D.
W. S. Patterson, Appleton, Wis.
F. W. Lamb, Chicago.
J. J. Miller, Chicago.
George H. Kirk, Chicago.
George M. Getschow, Chicago.
Howard S. Moss, Chicago.
P. J. Dougherty, Chicago.
John S. Brennan, Milwaukee.
Walter C. Lindemann, Milwaukee.
R. B. Watrous, Milwaukee.
H. B. McLelland, Chicago.
John J. Spear, Chicago.
C. G. Lamb, Chicago.
George L. Bottum, Chicago.
L. H. Drury, Chicago.
Oliver H. Schlemmer, Cincinnati.
F. H. Bass, Minneapolis.
Charles F. Newport, Chicago.
Willard K. Bush, Milwaukee.
J. C. C. Morris, Milwaukee.
C. H. Younglove, Chicago.
Fred W. Kauffman, Chicago.
E. R. Swan, Cedar Rapids, Iowa.
George D. Hoffman, New York.
J. M. Doesburg, Milwaukee.
W. S. Johnson, Milwaukee.
Clifford A. Loew, Milwaukee.
F. N. Bard, Chicago.
A. G. Tittelkon, Milwaukee.
W. K. Downey, Milwaukee.
Ralph Chatham, Milwaukee.
R. Warg, Milwaukee.
C. E. Oldacre, Toronto.
Wade H. Richardson, Milwaukee.
Wm. G. Bruce, Milwaukee.
F. F. MacNichol, Oshkosh, Wis.
John K. Allen, Chicago.
E. de F. Winslow, Chicago.
Frank P. Keeny, Chicago.
C. D. Brownell, Champaign, Ill.
A. G. Cripps, Akron, Ohio.
Prof. Storm Bull, Madison, Wis.
Charles E. Wehr, Indianapolis.
H. J. Leach, Milwaukee.

Erwin Hewes, Milwaukee.
Louis N. Riemer, Milwaukee.
E. E. R. Tratman, Chicago.
Samuel G. Neiler, Chicago.
H. W. Ellis, Chicago.
O. K. Patterson, Chicago.
Fred Sprinkmann, Milwaukee.
L. J. Mueller, Jr., Milwaukee.
J. E. Holland, Chicago.
Peter B. Bogart, Milwaukee.
Theo Weinshank, Indianapolis.
Frank G. Phegley, Chicago.
E. B. Gordon, Jr., Chicago.
A. A. Ainsworth, Chicago.
R. A. Widdicombe, Chicago.
John Bogenberger, Milwaukee.
Dr. Cremer, Dusseldorf, Germany.
Wm. H. Chenoweth, Jr., Chicago.
Warren Webster, Camden, N. J.
Wm. G. R. Braemer, Buffalo, N. Y.
J. H. Kinealy, St. Louis, Mo.
Wm. A. Green, Chicago.
G. W. Nichols, Milwaukee.
E. N. Murphy, Chicago.
B. E. Van Auken, Chicago.
D. E. Kennedy, Chicago.
August T. Kehm, Chicago.
Paul L. Biersach, Milwaukee.
E. D. Rigby, Milwaukee.
W. E. Durr, Milwaukee.
C. A. Tupper, Milwaukee.
Paul F. Johnson, Milwaukee.
J. P. Jogerst, Wausau, Wis.
C. W. Miller, Wauwautosa, Wis.
Rud Lacle, Milwaukee.
Chas. B. Kruse, Milwaukee.
James Graham, Milwaukee.
W. H. Halsey, Milwaukee.
John R. McClay, Milwaukee.
C. F. Backlin, Chicago.
John R. Allen, Ann Arbor, Mich.
S. R. Lewis, Chicago, Ill.
J. M. Stannard, Chicago.

The mayor of Milwaukee, Sherburne M. Becker, was introduced, and made a warm address of welcome to the delegates.

MAYOR BECKER'S ADDRESS

Mayor Becker said in part:

"It gives me great pleasure as chief executive of this city to welcome you to Milwaukee, and speaking in behalf of our citizens, I will say that each and every one of you is welcome within our gates. I am here also as a private citizen to give myself the pleasure of meeting such a company of representative business men engaged in an industry which holds such a prominent and vital place in the commercial life of our nation.

"I cannot talk to you to-day about your business obviously, because I know so little about it, but I can talk to you about Milwaukee, and I am ever ready to bespeak its praises and tell you of its achievement, its hopes and its future.

"Milwaukee has a population within its limits of over 350,000 souls. It is generally and also erroneously supposed that Milwaukee's chief industry is the manufacture of lager beer. I have no desire to belittle this great industry, but I do wish to correct a wrong impression, not because I believe that the manufacture of beer has not contributed largely to our credit, but because it is a fact that we have a yearly production of $97,000,000 in iron, steel and machinery industries, employing over 10,000 men, while the output of the breweries aggregates but $26,000,000 and employs but about 4,000 men. In other words, iron, steel and machinery lead in our output and beer comes second.

"The 3,468 manufacturing establishments in Milwaukee pay out in wages over $60,000,000 a year. The amount of capital invested is over $210,000,000, and the output of this great force of wealth, muscle and brain makes the magnificent aggregate of over $330,000,000 a year."

Professor Warren S. Johnson, of Milwaukee, responded to the mayor's greeting with some most interesting remarks on the subject of heating, saying among other things:

PROFESSOR WARREN S. JOHNSON'S RESPONSE

"All organized life is dependent upon food and heat and, with two exceptions, all civilized nations have been among those which have required, for a portion of the year, heat. The exceptions are the Egyptians, Caledonians, and those living in that region.

"A great many people think of Greece as a warm country, but it is not. Italy is certainly not a warm country. And Japan is a country that is in need of heat and heating apparatus.

"The progress of supplying artificial heat is one that has been taken up among the latest of all technical subjects. It is astonishing what makeshifts have been used until the last century for the production and utilization of heat for the purpose of keeping us comfortable.

"You know, of course, that up to the time of Queen Elizabeth and the Immortal Bard, there were no chimneys; the first was built on the first floor and the smoke went up through the corner of the house, and for centuries afterward very little improvement was made. In fact, it was only within the last century that very much progress was seen.

"Anthracite coal was considered only a black stone; it never was burned, as they did not know it was burnable. During the last century the common stove that is now relegated to the past, except in very primitive places, was never used.

"The progress has been made by utilizing heat more economically and distributing it more properly, and with this artificial heat, obtaining ventilation.

"The fire-place, which was used exclusively at the beginning of the last century, utilized 15 per cent. of the heat in the fuel and sent the other 85 per

cent. up the chimney. The modern way is to utilize 85 per cent. and send the 15 per cent. up the chimney, more or less, as occasion may be.

"The use of steam and the distribution of pipes for heating was an American idea, and was developed about the middle of the last century, and to-day the subject of artificial heating is better understood in America than in any other country. In fact, most of the appliances used in foreign countries are either obtained from America or copied from America.

"That pipes have taper threads on their end, in the shape of a wedge, is an American idea. Before that they had what is called running threads, the thread being cut the same size along its entire length. When they put a pipe into a radiator they turned it up a way and put on some candle wick and turned on a nut to keep it tight. That was so for many years.

"The Americans first got the idea of making very large pipes having plenty of room for the steam to circulate. Therefore they could utilize steam that had been used for power purposes and left with practically very little pressure, but still with a great deal of heat in it.

"It takes nearly five times as much coal to turn a pound of water into steam as it does to raise it from the freezing point to the boiling point, and when you come to use that heat by the exhaust of engines, you are gaining a great deal.

"Heating in European countries is largely done by high pressure steam with very small pipes. Some of the most prominent hotels in Paris to-day have heating pipes running along outside of the walls, tacked on, about as large as your finger, and they run them anywhere, in any way, very much as we run electric wires."

President Snyder extended an invitation to the mayor and through him to the citizens who might be interested to attend the various sessions of the meeting. He then reported the following gratifying condition of the treasury:

FINANCIAL REPORT

Cash on hand	$2,232.95
Unpaid dues	1,140.00
Dues from new members	185.00
Total	$3,557.95

"In addition," said the president, "there are on hand bound copies of the proceedings of a total value of over $5,000. The proceedings of 1906 have been edited and are now ready for the press, and we shall require about $2,000 to defray the expense of printing the proceedings of 1906 and 1907. We have only fifteen volumes of the first year's proceedings on hand.

"It is becoming more and more recognized that the bound proceedings of the society are a valuable working library. One of the members made the remark that he would not take $1,000 per volume for any which he could not replace. The growth of the society is something upon which we can congratulate ourselves. We now have 293 members, distributed among ten foreign countries and twenty-seven states of the Union.

"There is a growing sentiment that the strict requirements for admission of new members might be somewhat modified, but on this point there is much to be said on either side. The best evidence that we are not at the present time far wrong is the almost phenomenal growth of the society. The junior members have taken an increased interest in the work and a number of them have already made application for advancement. It would be just as well for the members in handing out the blank applications for membership among their friends, to remember the young men. There are many who are rather diffident in making their applications, but in time they will be the timber upon which the society must build."

Secretary Mackay read the list of new members elected since the last annual meeting. This list was published in our July issue.

The reports of committees were then called for.

Supplementary Report of Committee on the Collection of Data on Hot Water Heating

James Mackay, chairman of this committee, said: "The report that we have is simply a supplementary report that was submitted at the last annual meeting. Mr. Capron will read the report, giving the results of a test of an apparatus that had been installed:"

(It was decided not to make this report public at the present time.)

DISCUSSION

JAMES A. DONNELLY—Did you make any test to find out the uniformity of the circulation through directs and indirects so as to know what the actuating temperatures of the water were? Your average temperature through the indirects might be considerably lower.

MR. CAPRON—We had no means of finding that out. This test was made some seven or eight years ago.

MR. LEWIS—I judge that the circulation in the directs was even more rapid than in the indirects because by the rule the indirects are too small. I take it that the indirects were getting hotter water, and that is the reason they heated the house.

PROFESSOR ALLEN—I notice that Rule A, as I understand it, is based upon wall and window surface and Rule B is based upon wall and window surface and cubic

contents. The rule based on wall and window surface and cubic contents, in the ordinary room, will give too much radiation, and the rule based upon wall and window surface alone gives about the right amount of radiation in a room having small contents, but it is somewhat deficient where the room is very large, as far as rapidity of warming is concerned.

The loss of heat is through walls and windows, and therefore the calculation of the heat should be by wall and window surface.

MR. LEWIS—We submitted both to you to show that Formula A is the right one to use.

MR. DONNELLY—In regard to including the cubic contents, as a general thing, there is one troublesome factor in a formula, both in hydraulics and in the flow of air and steam, and that is the coefficient of friction. If we use a plenum system for this room, for instance, maintaining the air pressure somewhat above the pressure outside, we can figure very accurately the changes of air necessary. If we have direct radiation, affected by varying winds, it is difficult to figure the variation. In the ordinary residence or factory, with direct heating, we actually have on the windward side a leakage of air into the building, depending upon the wind blowing against it. We may have a current of air crossing through the building, heated on the windward side and again heated on the leeward side, which helps out the warm side. There are two ways of allowing for that, by adding a certain proportion of radiation for certain exposures or by allowing for more changes of air on the windward side of the building.

The normal leakage of air into a building on the windward side in seldom less than one change of air per hour and it may go as high as three or four.

You will find some rules for figuring radiating surface which have attempted to give the amount of leakage through an ordinary window. We can take it that there is so much leakage per window, or so much leakage per square foot of wall surface. This would figure about two changes of air per hour.

P. J. DOUGHERTY—Regarding leakage through walls, Mr. Swan in his paper quotes Mr. Joseph A. Moore, Inspector of Public Buildings of Massachusetts. In his excellent work on "Heating of School Buildings," Mr. Moore makes note there of a test he made in a schoolroom where all the windows, doors, etc., were reasonably tight. He gives an example of where he has forced 4,000 cubic feet of air a minute into that classroom with the plenum system. That goes to show if that 4,000 were forced in there without any exit for the air, natural leakage must be through the walls, windows, etc. So I think, in discussing the matter of the transmission of air through walls, the leakage is far greater than we anticipate, judging from that example. That is about twenty-four changes for an ordinary classroom.

PROF. J. D. HOFFMAN—I think that a great many of us who may have lived in furnace-heated houses at one time or another have often noticed that the air comes into the house without any appreciable means of exit. So there must be a very marked, appreciable loss of heat through the walls.

MR. DONNELLY—I have found in a great many houses they have not only a shingle roof which lets out a great deal of air, but they also have the habit of allowing the eaves to have a leakage of air. If a house has a tin roof, there will be less leakage of air in that quarter.

MR. CHEW—A house too tightly built is troublesome, as in that case the furnace man has to depend on the pressure of the outside air only. A house double-sashed, etc., leads to trouble in heating some particular room.

GEORGE D. HOFFMAN—I have always taken credit of being the pioneer in cutting openings in the baseboard of the inside walls of a house and making a channel by means of the lath and plaster on the two sides of the wall, and then cutting an opening in the attic. I used to put a little face-plate in the baseboard.

W. M. MACKAY—With these openings, sometimes accidentally made, I have found when the air in the attic was colder than in the room, we had a downdraught of cold air coming into the room.

GEORGE D. HOFFMAN—My practice was always to hunt out the warmest wall in the room and if I had a warm wall, I made it virtually a warm air flue and that, of course, created an upward draught.

PROF. ALLEN—There is a marked difference in the diffusion of air in a tiled and weather-stripped building compared to one that is not weather-stripped or tiled.

GEORGE D. HOFFMAN—In a large apartment building heated by hot water, the heating was entirely satisfactory except on one side of the building which was an exposed wall, or a wall to become later the party wall of an adjoining building. The owner came to me and asked if I could suggest any remedy. I said: "If you will paint that exposed wall, I don't think you will have any further trouble." He did so and he never had any further difficulty in heating that side of the building.

The following paper on "Heating and Ventilating Cars" was then read by the author, E. R. Swan, of Cedar Rapids, Ia.:

Heating and Ventilating of Cars*

By E. R. Swan.

The heating and ventilating of cars has received but little attention from those versed in the science of ventilation. What little has been done appears to have been by persons of no experience or knowledge of the principles that must be applied in order to secure it. Heating and ventilating has not been considered as a science of itself, and yet it is one of the most difficult problems in engineering.

Dr. Dudley, chemist, who designed the system of ventilating used on the Pennsylvania Railway, in writing upon the subject, says, in part: "It seems not improbable that if a vote of the general traveling public could be taken on the question as to what improvement or change in passenger cars at the present time would most conduce to the comfort of passenger travel, a very large majority of the ballots would be in favor of an improvement in car ventilation.

"It is to be confessed that the discomfort attendant on riding a number of hours in a stuffy, overheated passenger car, and especially the annoyance and discomfort from spending the night in an overheated, ill-ventilated sleeping car, are so great that it is not at all surprising that not only individual passengers, but also technical papers, and indeed the general press of the country, should from time to time break out into a tirade against the present condition of ventilation of passenger cars. Few problems in engineering have ever been undertaken which are so fraught with difficulties as the ventilation of cars on railroads. To supply them with the proper amount of fresh air throughout the year, and at the same time to exclude from them objectionable matter, such as smoke, cinders and dust, certainly here are difficulties enough. The shape of the car itself, the very small space compared with the large number of people, the question of keeping people warm, and the exclusion of objectionable matter from them, each one of these items is a problem in itself sufficiently difficult to tax the skill of the best experts, and, when all combined in one, it is little wonder, apparently, that progress has been so slow.

THE PROBLEM IN CAR VENTILATION

"Is it necessary to ventilate cars both winter and summer? It would naturally be expected that the doors and windows would be a sufficiently satisfactory source of fresh air in the summer season, and that, therefore, it would only be necessary to study the subject of car ventilation for the winter.

"Unfortunately, part of the problem, as already stated, is to exclude objectionable matter coming from without, and on dusty roads it is absolutely essential, even in warm weather, to keep

FIG. 1—DECK WINDOW VENTILATION

the doors and windows closed on account of the dust. Furthermore, smoke and cinders from the locomotive not infrequently are annoying even in the summer season, so that it seems fairly probable that a good system of ventilation should be operated both in winter and in summer. It has been urged in the technical press, and in conversation with would-be experts, that it is an easy matter to ventilate cars; simply let air in and provide places for the foul air to get out. I am compelled to say that I think this is a very unsatisfactory view of the case. In this climate it is unendurable to let fresh air into cars in proper amount in the winter season without warming it, and consequently it is perfectly clear that studies on ventilation must at the same time take into account the heating system of the car. Some systems

*Paper read at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Milwaukee, Wis., July 18-19, 1907.

of car ventilation, if they may be called systems, are little more than apertures in the car, and some so-called systems simply attempt to exhaust air from the car without providing inlets. So far as my knowledge goes, the experience with these systems is that neither of them can be used for any length of time; one can stand a little cold air for a few minutes, but when we come to consider the amount of air required, it is little short of an absurdity to attempt to ventilate a car without at the same time warming the air."

True and successful ventilation consists in the free access of warm, pure air into the car and the escape of bad or vitiated air therefrom. If the air is filled with dust, smoke and other objectionable matter it cannot be said to be pure, and it must be excluded. Cold draughts must be avoided, and a constant volume of fresh air supplied without fluctuation. Economy of operation is important, but must not be at the expense of efficiency. We must at all hazards avoid under-ventilation which is at the expense of health, and should avoid over-ventilation for the sake of the pocketbook.

VENTILATION THROUGH DECKS OF CARS UNSUCCESSFUL

The first attempt at improvement in the ventilation of cars was with the deck, which was put on the car for that purpose. This was before there were any systematic studies made of the subject of ventilation. While it is impracticable, the railroad companies appear to be unwilling to give up the idea, and nearly every attempt made to improve the ventilation has been done in connection with the deck, and no attempt made to warm the air before it enters the car. The deck could very well be omitted from the car so far as ventilation is concerned, as the ventilation of a car through the deck windows or any contrivance to be used in place of them is a fallacy, as the entering or outgoing air depends wholly upon the direction and velocity of the wind.

If the windows are open the air will enter only on the windward side and escape on the leeward side. Whether it will descend downward into the main body of the car will depend not only upon the difference in temperature of the interior and exterior, but upon the velocity at which it enters the car. The windows are hinged at the bottom and swing inward, and the entering air is deflected upward and across the ceiling until it meets resistance, when it will descend against the leeward window, which will deflect it out of the car. As shown in Fig. 1, some small portion will descend to the floor and be drawn across the feet and through the filth that may be on the passengers' shoes or the floor to the heaters, and when warmed pass upward to the breathing line loaded with impurities from the breath, persons and floor. The wire filter placed over the window openings, unless carefully attended to and cleaned, will choke up so the air cannot pass through.

COLD DRAUGHTS WITH DECK VENTILATION

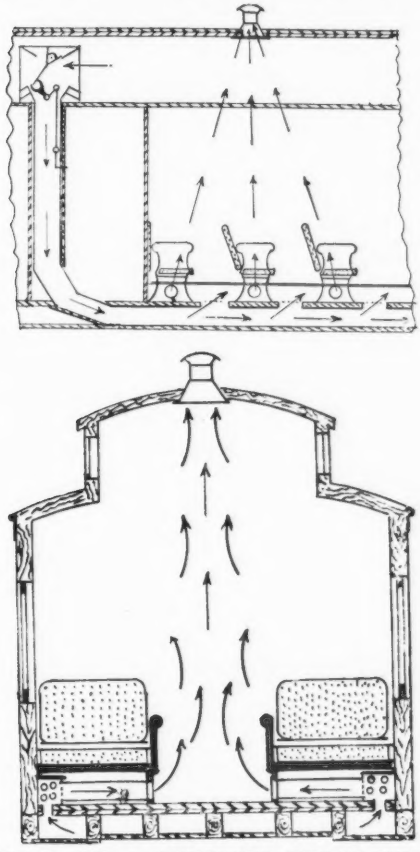
If the windows are closed on the leeward side, the cold air will descend and cause cold and unpleasant draughts, and will also cause a pressure in the car which will be governed by the velocity of entering air; when the pressure in the car is greater than on the exterior windward sides, the air will be forced back through the windows, and the fluctuating winds see-saw back and forth through the windows. The speed of the car will have no material effect on the entering air; it will depend entirely on the cross currents. If there are no cross currents there will be no entering air, and if there are cross currents the volume will depend upon the velocity of the cross winds.

The same things apply to summer ventilation of cars, except that the exterior and interior air will be so near the same temperature that the incoming air will not descend of its own accord, but only as it is forced down. If the windows in the lower part of the car be open for ventilation the cross currents will carry the breath of the person on the windward end of the seat directly across the face of the person sitting on the leeward end of the seat. Hence, ventilation of cars

should be done by downward currents only.

FAULTS OF WINDOW VENTILATION

If the ventilation must be done through windows, the windows should be opened at the rear end of the car on the windward side and at the front end and on the leeward side; but this will not and cannot successfully and satisfactorily ventilate a car, as the force of the moving current will cause the air to pass to the leeward side and forward to the outlet, where it will escape without thorough distribution, which is necessary for successful ventilation. No car or room can be successfully ventilated through the windows, winter or summer; windows must be closed on the windward side in case of strong winds, rain or dust storms, and only a seesawing effect will be produced through the windows on the leeward side. Hence, neither cars nor buildings should depend wholly upon windows for ventilation.



FIGS. 2 AND 3—SHOWINGD UDLEY SYSTEM OF CAR VENTILATION

If the windows are open in the deck it is no proof that fresh air is entering the car. The winds may be in the wrong direction, or the wire screen choked so that the air cannot pass through. The only sure proof that the fresh air entering the car will be in the cold draughts it will cause. Usually the person in charge does not consider the opening and closing of the windows in connection with ventilation, but to control the temperature. If the car is too warm the windows are opened, if too cold they are closed. No system of ventilation can be a success unless the air is warmed before it enters the car. It will not cost as much to warm the air before it enters the car as it will to warm it after it is in the car. It is a well-established fact that more air can be warmed by passing it over the heaters reasonably fast than at a slow movement. John P. Fox, a railway engineer, says that, according to a test made by the street railway company, it took 35 per cent. less current to heat a car if some of the current were diverted to a fan blowing outside air through the heaters.

THE DUDLEY SYSTEM OF VENTILATION

No car ventilator which is placed in the side of the deck or which does not warm the air before it enters the car is worth considering. The only one that we know of that has any claim to merit is the Dudley system. (See Figs. 2 and 3.) Pure air is taken in through two hoods at diagonally opposite corners. This air is conducted downward to longitudinal open spaces underneath the car. Through these spaces the air passes until it reaches apertures through the floor, whence it flows upward over heated steam pipes and out into the body of the car through large tubes placed under each seat; the foul air is removed through several ventilators placed on the roof of the car; the air supply is controlled by opening and closing the ventilators.

While Dr. Dudley does not apply the principles used by the heating and ventilating engineers in using the upward system of ventilation, and the control of the volume is in the outlets instead of the inlets, it is, however, far

ahead of the other so-called systems. Both the inlets and outlets should be operated to secure good results. While Dr. Dudley recognizes the importance of excluding dust and smoke from the car, he has made no provisions to prevent it, only by placing the intake above the top of the car.

If we have successful ventilation, the fresh air *must* be warmed before it enters the main body of the car, and this can be done only with some system of indirect heating, and the volume of air required will be governed by the proper location of the inlets and outlets. A large volume of air may be admitted into the car, and, if allowed to escape without proper circulation, very little benefit will be derived and much fuel wasted.

PRINCIPLES FOR VENTILATING BUILDINGS SHOULD BE APPLIED

Let us quote from "Heating and Ventilation of Buildings," by Professor Carpenter, past president of American Society of Heating and Ventilating Engineers and professor of experimental engineering, Cornell University: "The introduction of pure air can only be done properly in connection with the system of heating, and any system of heating is incomplete and imperfect which does not provide a proper supply of fresh air. The advantages of introducing warm air at or near the top of the room are, first, the warmer air tends to rise, and hence spreads uniformly under the ceiling; second, it gradually displaces other air, and the room becomes filled with pure air without sensible currents or draughts; third, the cooler air sinks to the bottom and can be taken off by a ventilating shaft."

So far as the system introduces air at the top of a room, it is forced distribution, and produces better results than other methods. When the inlet is placed in the floor, or near the bottom part of the wall, it is a receptacle for dust from the room and a lodging place and breeding place for microbe organisms. "The outlet for foul air should be as near the bottom as possible."

Mr. Joseph A. Moore, inspector of public buildings for Massachusetts, and who has been engaged for the past twenty years supervising and testing heating and ventilating of school buildings, after inspecting and experimenting on hundreds of buildings, says in his volume, "The School House":

"In cold weather the fresh air must be warmed to a number of degrees above the temperature at which we wish to have the room at the breathing line. Heated air will go to the top of the room, no matter where we admit it, and its distribution will begin there. By leading it there in pipes or flues we avoid carrying up dust and foul air with it, and we can locate the inlet and direct the flow of air so as to distribute it more evenly than if we admit it at the floor. The air will spread over the ceiling, the, falling current, caused by cooling, descends to the floor, and may be best taken out at the bottom of the room. If the air is admitted at the floor and taken out at the ceiling there is established a current between the inlet and the outlet, leaving the foul air in some parts of the room almost unmoved, and only slowly and partly drawn into the current, and the great loss of heat necessitated thereby calls for the consumption of a much greater quantity of fuel. The hot air is drawn off rapidly from the top, while the cold air remains at the bottom of the room. A school room supplied with 1,500 cubic feet of air per minute, with properly located fresh warm air inlets and foul air vent flues, will have the air at the breathing plane kept as pure as it will be when supplied with 2,500 cubic feet per minute with no proper provision for circulating the air.

"The economy of heating and forcing this extra 1,000 cubic feet of air into a room has never been satisfactorily explained."

Professor Carpenter and Mr. Moore are certainly experts in heating and ventilation. While they treat on the subject of ventilation of buildings, the same principles must be applied to cars for successful ventilation.

We do not purpose to advocate any particular standard of purity, but will leave that to the medical profession to determine. The quantity of air re-

quired will depend upon circumstances. When many persons are confined in a small space, like a car, not as much fresh air will be required as in a large space, where the foul air diffuses with the fresh air before its removal.

The tendency of a person's breath is downward, and by bringing in the warm air at the top of the car and removing it at the bottom, the air, as it descends to the breathing line, is all fresh, and as soon as we introduce sufficient air into the car to maintain a downward current it will not matter whether there are thirty or sixty passengers in the car; they will have pure air to breathe; the air will not be contaminated in the least; the diffusion of the gases takes place slowly, and before it can diffuse upward to above the breathing line it will have passed out of the car.

MOVEMENT OF EXHALED AIR DOWNWARD

Some writers claim that the tendency of the breath is upward. I *cannot* see how this can be. When the air is expelled from the nostrils it is started downward, unless you are standing on your head. Carbonic acid is said to be 22 to 26 times heavier than hydrogen; now what is there to cause it to rise except as it diffuses with the air? Then, there is not enough difference in temperature between the expired air and the air in a warm car to cause it to change its course in an upward direction. If this is true, why need we put in such a large volume of air? Is it not enough if we maintain a downward current of air? I am not taking into consideration the vitiated air from lamps; that we know flows upward on account of the extreme heat, and is started upward at a rapid velocity, and should be removed from the car independent of the ventilating system.

In ventilating cars or buildings two important matters must be taken into consideration. Under ventilation, which is at the expense of health, and over ventilation, which is at a money expense, both should be guarded against. Every cubic foot of air heated above that which is required for ventilation is at a money loss. If we heat 2,000 cubic feet of air when only 1,000 cubic feet are required, the extra expense for fuel will be enormous. Fluctuations are more liable to occur in cars owing to the variable changes in speed than in buildings, but in winter weather larger variations are bound to occur, and there will be but very little time in either cars or buildings but what there will be either under ventilation or over ventilation, if the apparatus is controlled by hand. It is utterly impossible to regulate the air supply by hand. A man may have only one opening to look after, and nothing else to do, and he cannot prevent fluctuations. The only thing he can do is to guess at it. If he is a good guesser he will come nearer than would a poor guesser. Hand regulation is all guesswork.

AUTOMATIC CONTROL OF AIR SUPPLY

There is only one way to prevent fluctuations and waste, and that is automatic control of the air supply. Several attempts have been made to design an automatic control of the air supply. Figs. 4, 5 and 6 is a system designed by the writer of an automatic control for the air supply and the inlet and outlet for car ventilation. Fig. 7 shows automatic control for the air supply to buildings. Fig. 4 is a vertical end view, with the lower portion of the casing removed. Fig. 5 is a vertical side view, with the casing removed. Fig. 6 is an automatic outlet for foul air. The numerals refer to the same parts in either figure.

DESCRIPTION OF APPARATUS

In describing the devices and referring to the drawings, numeral 1 designates the top of the car, and numeral 2 the bottom of the car.

The apparatus is arranged between the top and bottom of the car at either end. In a combination car it can be located at the partition, and will heat and ventilate both compartments with the one apparatus.

Numeral 3 is the intake for fresh air located on top of the car; numeral 4 is an automatic movable valve, which moves on track 5, located on the inner side and near the top of 3; 6 is the downtake pipe, opened at the lower

end and provided with a plurality of vertical openings or slots (Fig. 7) near the lower end.

The passage of air is governed by valve 7, which is mounted for movement longitudinally and rotary, and which receives the lower portion of pipe 6; 7 has corresponding openings, as in 6, and registers therewith. The openings in 6, however, are somewhat longer than in 7, in order to maintain the same vertical length in slots 8 when 7 is forced downward by the pressure of the inrushing air. The rotary movement is produced by pin 9, which is attached to pipe 6, and extends outward through the spiral slot 10. Pipe 12 and valve 13 are constructed in the same manner. Pipe 12 is the foul air outlet, and has connection with 14, in which is located two automatic dampers, 15, connected by rod 16.

Valves 7 and 13 are connected to a cross arm 17 by a flexible connection *A*; 17 is firmly attached to shaft 18, which operates in suitable bearings *B* and *C*. Valves 17 and 13, being attached to opposite ends of lever 17, balance each other. The downward movement of valve 7 causes an upward movement of valve 13.

An important feature of the apparatus is the special means utilized in order that the quantity of air admitted to the car may be certain, and not subject to variation due to the variation in the speed of the car. To accomplish the above peculiar regulating mechanism for governing the movement of the valves 6 and 13 is employed. This regulating mechanism includes the arm 19, attached to the end of the shaft 18 for movement therewith, and curving outwardly and downwardly from said shaft. Arranged to connect with the upper surface of the arm 19 is a weighted lever 20, which is pivoted at one end, as shown at 22; 21 is an adjustable, slidable weight, the position of which may be fixed with a suitable set screw. The co-operation of 19 and 20 is as follows:

Normally, the outer end portion of the lever 20 bears against the arm 19 near the point of connection of the latter with shaft 18. When the car begins to move the amount of fresh air passing down the fresh-air flue 6 increases in direct ratio to the increase in the speed of the car; on the increase of the velocitty of the air passing into flue 6, the increased pressure due to the increased velocity of such air, with regard to valve 7, is resisted by the regulating means, for the reason that the connection *A* between the valve 7 and the lever 17 begins to pull downwardly on said lever, thereby gradually raising the arm 19 and gradually causing the inner end of the lever 20 to approach the outer end of said arm 19.

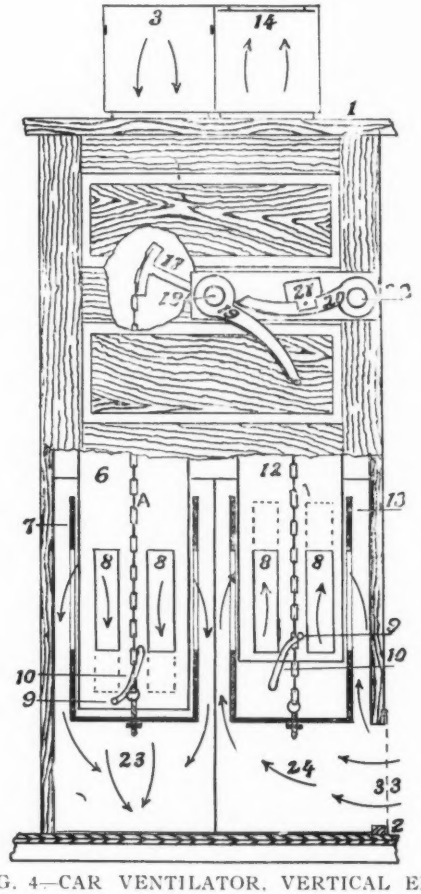


FIG. 4—CAR VENTILATOR, VERTICAL END VIEW, WITH LOWER PORTION OF CASING REMOVED

As the point of contact of the lever 20 approaches the outer end of the arm 19, it becomes obvious that said lever 20 obtains a greater leverage with respect to the arm 19, and the weight brought to bear on arm 19

gradually increases, due to the increased velocity of air pouring into the flue 6, causing a gradual downward movement of valve 7, which movement is retarded and is resisted by a gradual

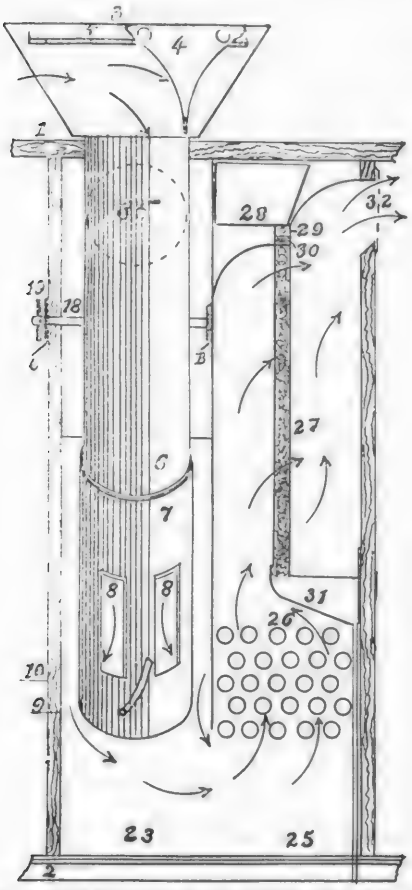


FIG. 5—VERTICAL SIDE VIEW OF CAR VENTILATOR, WITH CASING REMOVED

increasing weight connected with the valve for that purpose. As the area of the opening 8 decreases, as the velocity of the air in flue 6 increases, the quantity of fresh air passing into the car will be certain, with no fluctuation of the fresh air.

The quantity of foul air withdrawn from the car through the foul-air pipe 12 is also proportionate with the velocity of air passing into the flue 6, as the amount of suction in the passage 14 depends and is proportionate with the velocity of air. As the velocity of the air entering flue 6 decreases, because of the slowing down of the speed of the car, the pressure of air on the bottom of the valve 7 decreases and the same moves upwardly, under the influence of the weighted lever 20, decreasing as the point of contact of these parts approach the shaft 18.

The valve 6 is placed in compartment 23, and valve 12 in compartment 24, the indirect heating 26, and the air washer 27 is placed in compartment 25. The air washer 27 may be of any substantial form which embodies spaced sides, between which is located the filtering material, which may be excelsior or the like. Aluminum excelsior would be preferable. The filtering material is kept in a moist condition by being supplied with water from tank 28, or by any other suitable means (from one to two gallons per hour will be required), through a small perforated pipe 29, with a suitable bib for regulating the water supply. Cotton or similar spreading absorbent substance, as indicated at 30, should be located at the upper portion of the filtering material, just below the pipe 29; said cotton or material effectively spreading the mostening fluid over the filtering material. A drip pan 31 is connected to the lower end of the filter 27, receiving the dirt washed from the air. A suitable pipe is connected to the drip pan and through the bottom of the car, through which all dirty water and filth passes out of the car.

34 is a revolving door to be used when warming up the car or when not occupied.

35 are dampers located near to top of pipes 6 and 12, to close the inlet and outlet when 34 is used for revolving the air or when passing through a tunnel.

HOW THE APPARATUS WORKS

Generally describing the operation, it will be obvious that as the car commences to move the air will pass into the intake 3, nearer the direction in which the car is traveling. The inrush of air will exert a pressure against the valve 4 and move it to the leeward side of the pipe 6, and deflect the air downward in pipe 6 to the end of the passage and exert a pressure against the bottom of valve 7, until it closes the openings 8 in flue 6 and 12 to a pre-

determined extent. The fresh air passes through the openings 8 and follows in the lines indicated by arrows through the heaters 26 and the air washer 27 into the car at 32.

While the fresh air is being admitted to the car, as above described, the foul air is being removed through the opening 33, at the floor line and upward through the openings 8 and pipe 12, and through the foul-air outlet 13 at the leeward end. Dampers 15 in outlet 14 (Fig. 6) are automatic. When the car is moving the pressure of the air on the windward damper 15 forces it downward and raises the leeward damper 15 horizontally, opening the passage to the leeward end. The fresh entering air and the outgoing foul air will be proportionate, and there will be no vacuum in the car. A slight plenum should be maintained at all times. This is very important if we wish to avoid cold draughts through cracks and crevices. The wind will have the same effect as the moving car. If the wind is moving in the same direction and faster than the car is traveling, the valves and dampers will be forced to the proper position to receive fresh air and to expel foul air, and will always maintain the air supply.

The intake, the outlet and the volume of air are automatically controlled and need no attention whatever, and it is the only ventilator that automatically controls the air supply to a certain quantity. The same amount of air will enter the car under all conditions after a speed of ten miles is obtained. It is a combined system of plenum and exhaust, using the movement of the car for power instead of a fan. In cold weather the heaters will always cause a circulation of air, and some ventilation (about five-eighths) will always take place when the car is standing.

Fig. 7 shows the manner of construction for large air controllers. Pipe 6 and valve 7 may be of any size. If reduced in size at the lower end to 27 inches, which is approximately equal to 4 square feet in area with a velocity of 5 miles per hour, then the slots 8 will begin to close, and when the velocity is 10 miles per hour the pressure will be 2 pounds and the openings will be one-half closed. At 20 miles the pressure will be 8 pounds and the slots three-quarters closed. At 40 miles the pressure is 32 and the slots seven-eighths closed. The same mechanism is used, but the curve in

FIG. 6—DETAIL OF AUTOMATIC AIR OUTLET FOR CAR VENTILATOR

spiral slot 10 is changed, and weight *D* is placed at the end of lever 17 as a counterbalance in place of valve 13.

Dusty air must be, of necessity, a dry air. By passing it through the filter all dust and other obnoxious matter will be removed and the humidity will be greatly improved.

EFFECT OF MOVEMENT OF TRAIN

At a speed of ten miles per hour the air pressure is one-half pound per square foot, and the slots 8 are wide open. As the speed of the car increases the slots gradually close, which reduces the air supply. When a speed of twenty miles is reached the pressure is 2 pounds per square foot and the openings are closed one-half, which allows the same quantity of air to pass as at ten miles per hour. At forty miles per hour the pressure is 8 pounds per square foot, and the slots 8 are closed three-fourths. At eighty miles per hour the pressure is 32 pounds per square foot, and the openings are closed seven-eighths of the way, and the same volume of air will pass through at any rate of speed.

It will be seen that the supply of air is under perfect control, and over ventilating cannot take place; hence, there will be a large saving in the expense for fuel. It seems to be the opinion of some that a fan will supply a constant volume of air at all times. This is an erroneous idea. If there is sufficient wind to cause a plenum in the fresh-air compartment the fan will deliver more air than when it is normal, or a vacuum in the fresh-air compartment, and there will be fluctuations of the air

supply and under or over ventilation. It would be interesting to know how much is wasted by over ventilation.

FANS OF NO ADVANTAGE

It has been suggested that fans be used in car ventilation. Fans would be of use only when the car was moving very slowly or standing still. As soon as the speed of the car is greater than the velocity of the air driven by the fan it would be of no advantage. Usually, when the car is standing the doors are open, and thorough distribution will not take place in any event. If the inlet for fresh air faces the direction the car is moving and the outlet toward the rear, the movement of the car will produce the same result as a fan.

It is generally considered that there is more excuse in car ventilation, and that it is more difficult than the ventilation of buildings. We do not think that that is the case. In building ventilation there is never a fixed point to work from. The wind is changeable, and it is not known one day from what direction the wind will be next day, whether the wind will blow into the inlet or syphon the air out. With a car it is different. We are always sure of the air entering the inlet if it faces in the direction the car is moving. If the wind should blow in the direction and faster than the car is moving, by using an automatic intake, which changes the position of the intake to conform with the direction of the wind, we would still have an air supply passing into the car. Cross winds will not affect it, any more than the movement of the cars affects the air supply passing into the windows in the side of the car. When we have once designed a perfect system for a car it can be applied to all cars. Not so with a building. Each and every one is a different proposition. Even in duplicate buildings outside conditions and locations of buildings or trees will change the direction of the air currents, and different engineering will be required.

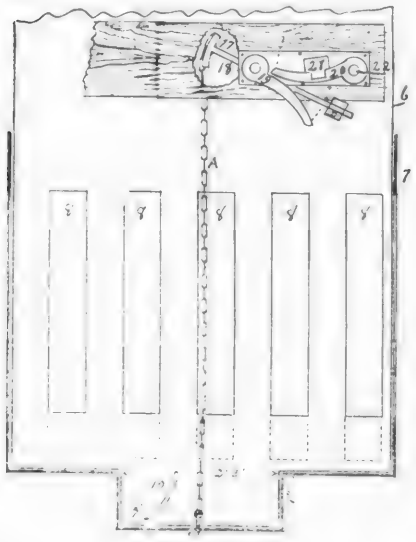


FIG. 7.—SECTION OF CAR VENTILATOR, SHOWING VERTICAL OPENINGS NEAR LOWER END

CAR VENTILATION A SCIENCE

The reason car ventilation has not been more successful is the heating and ventilation has not been considered a science, and the ventilating engineer has not been called upon to solve the problem, but it has been left to men who, though they may be versed in the other sciences, may know nothing of the principles of ventilation. Many technical papers and others appear to think that all that is necessary is a hole in the side of the car. Some of them advocate two holes, and think that is all that is required. They do not appear to understand that the air must be moved, and some kind of force or power is required to move it. A very simple experiment would soon convince them. If they will open their mouths as wide as possible and stop expanding and contracting their lungs for five minutes, they will be convinced that something is required more than the holes. They would be dead, and that ought to convince them that the theory is wrong; but it might not. Some people do not like to admit they are wrong.

Whether cars will ever be properly ventilated will depend upon the operating companies or the law-makers. That it can be done there is no doubt, and the expense would be nominal. One cent for each passenger carried on the railroads for one year would ven-

tilate every passenger car in the United States, and the saving of fuel would more than repay the expense in three or four years. It would seem that no better time could be selected to introduce ventilation upon the railroads than the present time. Hundreds of steel cars are being, or about to be, built, which will not be ventilated any better than the cars now in use. While I am not an authority on car building, it would seem to me that the deck might be left off and a large saving made. The deck is of no use as a ventilator, and surely does not add to the beauty of the interior of the car. The extra cost of building the deck would ventilate a dozen or more cars. Conditions are much worse than they were before the vestibule cars were introduced, as opening the doors does not materially help the ventilation. The opening of doors between cars only allows the impure air to drift back. More complaint is made about the sleeping cars than coaches, yet the chair cars and coaches are worse than the sleepers, for the reason that many more people are in them, and the breathing space is at least 50 per cent. less. Surely the poor man or woman who is obliged for the lack of funds to ride in the coach is as much entitled to pure air to breathe as is the wealthy passenger who rides in the Pullman. Fresh air is too cheap, the supply is too large to be stingy of it, and health is too important to be deprived of it.

Is it necessary to filter or wash the air? It would seem that it would be, a part of the time on steam roads at least, in dusty weather. Dr. George A. Soper, of New York, in discussing the quality of air in the New York subway prior to 1906, said: "The examination of the dust in the subway showed that over 60 per cent. was iron." He explained the large proportion of iron by the wear of the brake shoes, which he calculates at one ton every month for each mile of subway, to which should be added the wear from the rails, wheels and contact shoes. It would seem in that case that the air should be washed, and the wash-water and filth be taken into a tank underneath the car, and the tank emptied at terminals, when it would not get back into the subway, and if the cars were properly ventilated, and the windows kept closed, would exclude the disagreeable noises.

DISCUSSION

SAMUEL R. LEWIS—I think it would be a good idea for some of our committees, or the one on ventilation, to get something in the way of laws for the proper ventilation of cars.

PROF. JOHN R. ALLEN—What is the possible velocity of air obtained in the flues or ducts used in such a car ventilating system, and what allowance is made for the variation of speed of the car in its operation? Under comparatively low speeds, would it be possible to acquire a sufficient velocity of air in the flues to give the car proper ventilation?

MR. SWAN—My idea is that we must establish some fixed point to start from. If we have an inlet one foot square, when the car is running ten miles an hour, not allowing for friction, there would be 880 cubic feet of air going into the car. If you want more air than that, by moving a weight on the bar, the air would not commence to flow until you were running fifteen miles an hour and in that way you could regulate it exactly.

MR. LEWIS—Did you not state to me that you had tested your apparatus and had found that it would operate with a velocity of five miles an hour?

MR. SWAN—Yes, sir, but not on a car, unless I took too much space. With a large inlet, as in a building, by having the lower portion of the inlet twenty-seven inches in diameter, or approximately four square feet, it would commence to operate at a velocity of five miles an hour. It does not matter how often you change the velocity of the wind, no more air will pass through at a rate of ten, fifteen or twenty miles an hour than at five.

PROF. JAS. D. HOFFMAN—I think Mr. Swan has touched on a subject which should be followed up. I notice he says "it will not cost as much to warm the air before it enters the car as it will to warm it after it is in the car." Would it not be well if Mr. Swan would state why it would cost more one way than the other? Possibly he means the mechanical difficulties in getting the air to the heater, resulting in the loss of heat on that account.

MR. SWAN—If we pass air through heating coils before we warm it, it travels at a greater velocity than if we dropped it through a hole here and left it to find the radiator itself. You can warm more air by passing it over radiators at a reasonably rapid velocity than at a low velocity. That is, the efficiency of the radiator is greater.

Report of Illinois Chapter

Following the discussion of Mr. Swan's paper a report of the Illinois Chapter was presented, covering the history of the chapter since its organization in 1905. "The chapter was incorporated on March 5, 1907," continues the report, "and although other members of the society were entitled to become charter members of the chapter, only seventeen responded to the call, these being as follows: W. L. Bronough, Edmund F. Capron, Jas. H. Davis, Willard B. Graves, John F. Hale, August Kehm, Samuel R. Lewis, Jas. Mackay (charter member of parent society), D. F. Morgan, Geo. Mehring (charter member), N. L. Patterson, Wm. A. Pope, Jas. M. Stannard, T. J. Waters (charter member), and Rob't A. Widdicombe; Associates: John K. Allen and John Boylston.

"The chapter holds monthly meetings from October to May of each year, and arrangements have been made for the use of the meeting rooms of the Western Society of Engineers in the Monadnock Block, Chicago. We have the use of its extensive library and reading room as well as the meeting room once a month. It also places at our disposal a lantern for reproducing views of buildings, apparatus or drawings for the purpose of illustrating any papers that may be read from time to time. At the five regular monthly meetings which were held this year the attendance has been very satisfactory, and the prospects are favorable for a successful season this fall and winter.

"The American Society of Heating and Ventilating Engineers has forty-three members resident in the State of Illinois, twenty-three of whom have identified themselves with the chapter, and we have expressions from most of the others to the effect that they will join us in the fall.

MEETINGS

"The meetings held so far have been instructive and profitable, four papers having been presented, as follows:

"Reading and Explanation of Data Relating to Hot Water Heating and Boilers, by Samuel R. Lewis and E. F. Capron, members of the original committee.

"Description of an Extensive Heating and Power Plant Designed and Installed, by August Kehm. Original working plans used to illustrate the talk.

"Illustrated talk, by E. F. Capron, entitled Unusual Gravity Return Steam System.

"Description by J. F. Hale, of an overhead hot air system, unique in its construction and containing features that should be of interest to all, although relating to furnace heat.

"The Committee on Compulsory Legislation has done some excellent work, having met many times and drawn up a bill which was presented to the last General Assembly of the Illinois Legislature, but unfortunately it was impossible to have it brought to the third reading. We have every assurance, however, that the bill will be favorably considered when the Legislature next meets, as it is generally understood that the motive behind the bill is the same as in the case of other states having similar laws, that is the proper ventilation of all public buildings and institutions."

Afternoon Session, July 18

The first paper at the afternoon session was entitled:

Heating and Ventilating a Group of Public Schools

By Samuel R. Lewis

(This paper was published in our July issue.)

DISCUSSION

Mr. Lewis—The particular interest in this plant is that, unlike the ordinary central heating plant, it takes care of buildings that are only heated during school hours. I think there are only four or five plants of that kind in the country. Most central plants for a group of schools take care of dormitories and cottages, so that they are heated over night. There is one line of discussion I should like to suggest. In the competition through this territory there is constant warfare between those who advocate and those who do not advocate a central blast heating plant, with separate ducts leading to each room, having a damper in each separate pipe leading to each room, so that the heating and ventilation are controlled from the basement in the plenum chamber by the air that is admitted. You may have a little auxiliary radiation to aid in warming up the chairs and desks, because until they get warm the room is not habitable.

I prefer the type of plant using a central plenum chamber, with separate pipes to each room.

(At this point President Snyder resigned the chair for the remainder of the session to Vice-President James Mackay.)

Professor Allen—I think each system has its place. At the University of Michigan we use direct radiation for heating and fans for ventilating. Both fans and radiators are automatically controlled. In a building such as a Y. M. C. A. building you have a gymnasium which is only heated to 65°. On the other hand you have a dressing room heated to 70°. There it is necessary to install a double duct system. Referring now to the fan system with a plenum chamber, very often you can apply it to a hospital where heat and ventilation is kept on all the time.

MR. LARSEN—The author has calculated the amount of air according to the number of pupils. In getting at that did he not have to apply some rule first?

MR. LEWIS—In the ordinary schoolroom, where there are thirty or forty pupils, I knew from previous experience, that it required an air change at this temperature once about every fifteen minutes. We are changing the air in these rooms, on the average, every seven or eight minutes. In a few rooms the air is proportioned by Rule A, given this morning.

MR. LARSEN—What amount of radiation, on a blast coil, do you need in comparison with direct radiation?

MR. LEWIS—The simple rule is this: Having the number of pupils and knowing the amount of cubic feet of air, divide the cubic feet of air by 4. That gives the number of linear feet of pipe required in blast coil. It is based on the condensation of steam per square foot of surface.

MR. LARSEN—A member from Michigan says he can heat his building cheaper with direct radiation than he can with blast coils. Last year we built two new buildings and we put in practically the same plant described here by Mr. Lewis, with a few differences in minor details. For instance we had both direct radiation and the blast system, because the School Board in Duluth would not permit the installation of simply a blast system. This plant was ready to turn steam into the directs the 1st of December. The fan system was not ready until January 10. We heated the building for the contractors to finish their work during December and the first ten days in January with direct radiation. When I had the fan system ready I turned that on and I heated the building the rest of the winter with about a third less fuel than I used with the directs alone.

The rule I use is that laid down by the Scranton School. In that rule it is required that we proportion the amount of heating surface by first figuring the exposure and reducing that to the equivalent of glass and then figure the amount of air changes we want and the air that escapes will be, of course, the same as the amount we force in. Multiply the amount of air delivered into the building by 9-10 and you have the amount of heat that is given off by the air changes. Add that to the amount of heat lost figured through the glass exposure and you have the amount of linear feet of pipe.

MR. LEWIS—I think that rule checks up very closely, but the prime requisite of a ventilating plant is to provide a given amount of air for each pupil in the room.

MR. LARSEN—Suppose you have a room of 12,000 cubic feet and it takes, we will say, 240 square square feet of direct radiation to warm that room, how much blast coil would you need for that room? Would you need more or less than for direct radiation?

MR. LEWIS—You would need less. For instance, an eight-room school building might require 2,500 square feet of direct radiation and that building would only take 1,200 square feet of blast coil to get the same result. It is three times as efficient per square feet.

MR. LARSEN—That bears out my doctrine.

VICE-PRESIDENT MACKAY—I think, roughly speaking, about two-thirds less surface in a blast coil will do the work of a given surface in direct radiators.

MR. LEWIS—A point was brought up by Mr. Swan regarding the facility with which you could heat fresh air or foul air. Someone has said that with a fan system he could heat a building much quicker in the morning by taking the cold air from the outside. I do not think it had so much to do with the cold air outside as that by rotating the air he did not get the full power of the fan.

But do not lose sight of the fact that direct radiators, sometimes, in a room heated by a blast system are a life-saver, because we occasionally get an area of skylight and the pupils back there get cold draughts.

PROFESSOR ALLEN—Mr. Lewis brings up a point I have had very much at heart. Take high windows, ten or fifteen feet high, with a large amount of glass surface, and put in a blast system alone, there would be great trouble with downdraughts, but by putting in direct radiation you would cut off the down draughts and save the plant.

VICE-PRESIDENT MACKAY—I think Mr. Lewis, in giving his condensation of the direct radiation per hour, was very conservative; in fact, if he was only getting the radiation he states, the radiation was not as effective as it should have been.

MR. LEWIS—I have never made any measurement to tell, but from what I could gather from technical books, it always seemed to me that 3/10 of a pound was more than any radiator would do.

PROFESSOR ALLEN—In some 400 or 500 tests on various forms of radiation we seldom got condensation to exceed ¼ pound.

VICE-PRESIDENT MACKAY—In checking that up, you used commercial rating?

PROFESSOR ALLEN—Yes, sir.

MR. LARSEN—Suppose we have a building where it is impossible, for lack of room, to put in a coil, can we get the same results by placing indirects under the basements ducts leading to each room, provided we use the same amount of radiation and have our mixing dampers between the indirect and the room?

MR. LEWIS—I think you are getting the same results when you are operating and heating the building at the same time.

You lose one advantage of the blast system over the direct system. In the ordinary direct system you have your radiation scattered through the building. The sun shines from the south and effects the warming of that side of the building very much. The north wind is blowing on the other side and the rooms are cold. On that particular morning, if you could take half of the directs lying idle on the south side to help out on the north side, you would get along better and save fuel. With the blast system when the rooms on the south side get warm the heat is shut off and is available on the other side.

SECRETARY MACKAY—Our practice in the East in school buildings, libraries and hospitals of large size is to place cast iron indirect radiation at the base of the flue instead of in a plenum chamber and we seem to get better results from it and we do not use the fan at all times.

I would like to ask Mr. Larsen if in the case he referred to he used both systems of heating the same length of time, or if he used the direct twenty-four hours a day and the hot blast only when the workmen were in the building.

MR. LARSEN—In the building under consideration we used it twenty-four hours.

SECRETARY MACKAY—Were your directs large enough to heat the building without the indirects, or did you have more radiation, in proportion, in your directs than in your indirects?

MR. LARSEN—I had plenty of radiation in the blast coils to heat the building as I figured, but the directs were not enough to heat it under all conditions. The rooms contained about 10,000 cubic feet each and there was 180 square feet of direct radiation in each room.

SECRETARY MACKAY—So that the hot blast was really under more favorable conditions for heating than the directs.

MR. LARSEN—Yes.

The next paper read at this session on the design of a plenum system of warm air heating is presented herewith.

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*Design of a Plenum System of Warm Air Heating for a School or Office Building**

BY J. D. HOFFMAN

In the following discussion, the three building plans, Figs. 1, 2 and 3, may, for our purpose, represent a typical two-story and basement office and school building. The object of the writer has been to work through the important parts of the design to show how such a line of work could be accomplished.

The subject of heat loss from the building is one in which a comparison of the results obtained from the various formulas would have been valuable; but since such comparisons have frequently been made, it was thought best to confine these remarks mainly to the calculations around the heater room and in a brief way to the lay-out of the ducts and registers.

HEAT LOSS FROM THE BUILDING

The formula:

$$\text{Radiation loss} = \left(G + \frac{W}{4} + \frac{nC}{55} \right) (T - t)$$

was used in calculating the heat loss from the building. In this formula n is given with the other values in Tables I, II, and III; also $T - t = 70$.

It will be seen from Tables I, II, and III that the total heat loss from the walls and windows is 1,483,251 B.T.U. per hour; with an outside temperature of 0° F. and an inside temperature of 70° F. Now if the air leaves the heating coils at 140° F., which may be considered the best service for a cold day, then the heat radiated from the walls and windows will equal the heat wasted in the exhausting of the air from the building and the total heat lost from the building will be

$$H = 1{,}483{,}251 + 1{,}156{,}935 \times (70 - 0) \div 55 = 2{,}966{,}502 \text{ B.T.U.}$$

AMOUNT OF AIR NEEDED AS A HEAT CARRIER

In column 6 of the tables are tabulated the volumes of air needed to carry the heat to the various rooms. These values are obtained by multiplying the heat loss by 55 and dividing by 70; = heat loss × 0.78.

*Paper read at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Milwaukee, Wis., July 18-19, 1907.

TABLE I.

BASEMENT FLOOR DATA SHEET.

Room.	n	Heat loss in B.T.U. per hour from room not counting ventilation.	Heat loss counting exposure.	Per cent. added.	Cubic feet of air needed per hour as a heat carrier.	No. of registers installed.	Total net area of registers in sq. in.	Size of registers in inches.	Size of stack in inches.
1	1	51,520	.....	.....	40,185	2	322	13 x 20	13 x 13
2	¾	74,200	.....	.....	57,876	..	...	.....	.....
3	1¼	29,400	.....	.....	22,932	1	184	17 x 18	17 x 13
4	1¼	36,260	.....	.....	28,283	1	226	17 x 21	17 x 13
5	1¼	42,210	.....	.....	32,923	1	263	17 x 25	17 x 13
6	1¼	35,350	.....	.....	27,573	1	220	17 x 21	17 x 13
7	...	.....	.....	.....	.....	..	...	.....	.....
8	1¼	16,520	.....	.....	12,885	1	103	13 x 13	13 x 8
9	1¼	16,520	.....	.....	12,885	1	103	13 x 13	13 x 8
10	1¼	42,210	.....	.....	32,923	1	263	17 x 25	17 x 13
Totals.	...	344,190	.....	.....	268,466	..	...	.....	.....

TABLE II.

FIRST FLOOR DATA SHEET.

Room.	n	Heat loss in B.T.U. per hour from room not counting ventilation.	Heat loss counting exposure	Per cent. added.	Cubic feet of air needed per hour as a heat carrier.	No. of registers installed.	Total net area of registers in sq. in.	Size of registers in inches.	Size of stack in inches.
11	1	81,130	.....	.....	63,281	2	506	17 x 24	17 x 13
12	¾	115,430	126,973	10	99,039	4	792	17 x 18	17 x 13
13	1¼	40,500	44,583	10	34,775	1	278	17 x 26	17 x 13
14	1¼	55,370	60,907	10	47,507	2	380	17 x 18	17 x 13
15	1½	63,840	70,224	10	54,775	2	438	17 x 21	17 x 13
16	1½	48,440	50,862	5	39,672	1	317	17 x 30	17 x 13
17	1	51,940	.....	.....	40,513	2	324	13 x 20	13 x 13
18	1½	23,660	24,843	5	19,377	1	155	13 x 20	13 x 13
19	1½	23,660	.....	.....	18,455	1	148	13 x 20	13 x 13
20	1½	63,840	.....	.....	49,795	2	398	17 x 18	17 x 13
Totals.	...	540,100	.....	.....	467,189	..	...	.....	.....

TABLE III.

SECOND FLOOR DATA SHEET.

Room.	n	Heat loss in B.T.U. per hour from room not counting ventilation.	Heat loss counting exposure.	Per cent. added.	Cubic feet of air needed per hour as a heat carrier.	No. of registers installed.	Total net area of registers in sq. in.	Size of registers in inches.	Size of stack in inches.
21	1	81,130	.....	.....	63,281	2	506	17 x 24	17 x 13
22	1	17,150	.....	.....	13,377	1	107	13 x 13	13 x 8
23	1	103,460	113,800	10	88,764	2	710	21 x 28	17 x 13
24	1	17,150	.....	.....	13,377	1	107	13 x 13	13 x 8
25	1	31,900	35,189	10	27,447	1	220	17 x 21	17 x 13
26	1	48,580	53,438	10	41,682	2	333	13 x 20	13 x 13
27	1	93,030	102,333	10	79,819	2	638	17 x 30	17 x 13
28	½	28,420	.....	.....	22,163	2	177	13 x 15	13 x 8
29	1	37,380	.....	.....	29,156	1	233	17 x 21	17 x 13
30	1	54,110	.....	.....	42,206	2	338	13 x 20	13 x 13
Totals.	..	598,961	.....	.....	421,272	..	...	.....	.....

PLATE 1
HEATING AND VENTILATING PLANS
BASEMENT PLENUM SYSTEM
CEILINGS 13′
WALLS 6′ EXPOSED
WINDOWS 3′x 6′

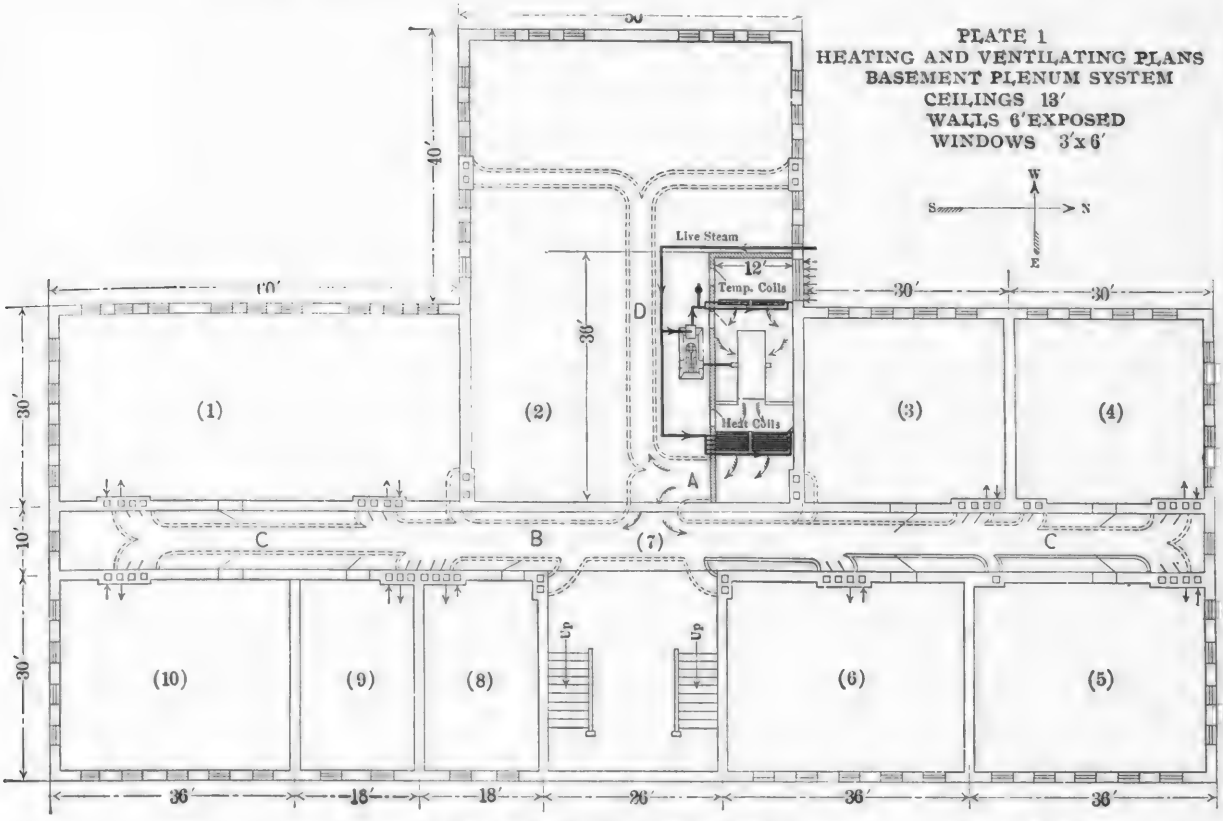
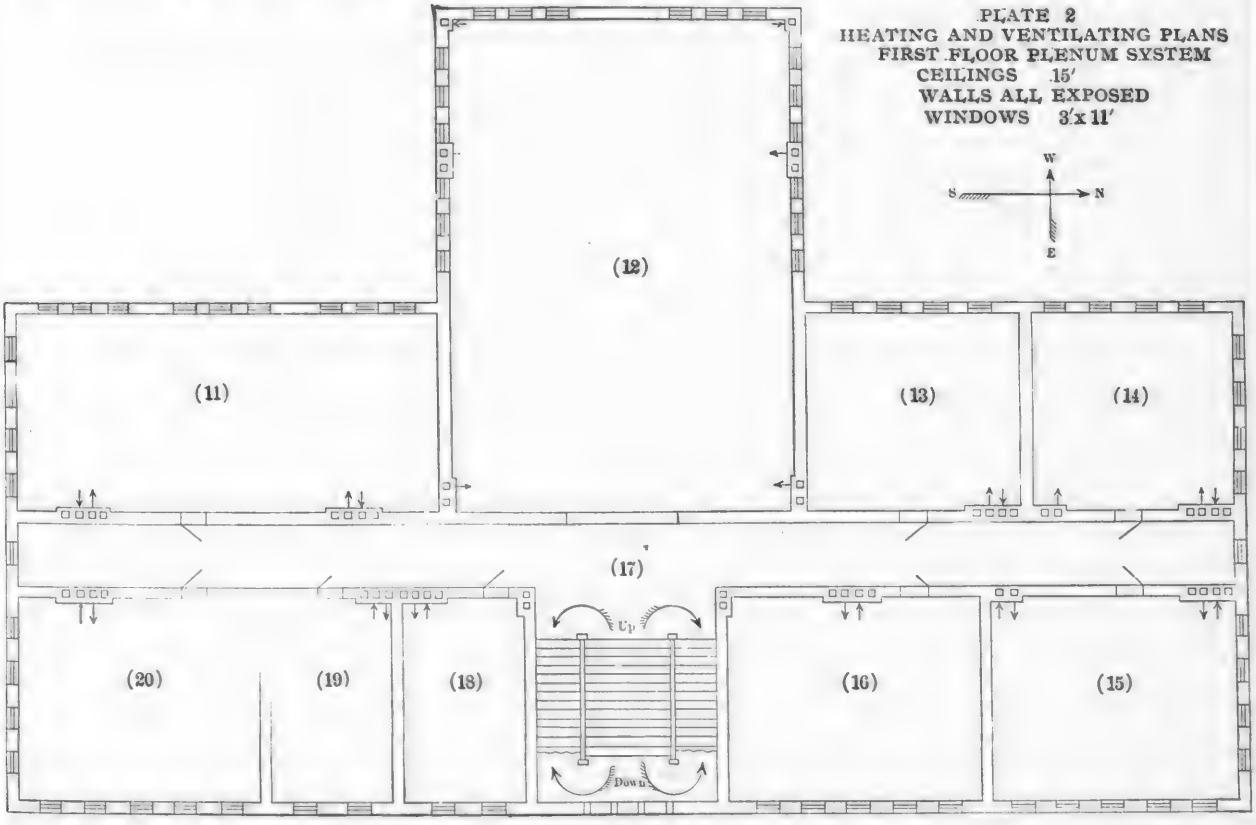


PLATE 2
HEATING AND VENTILATING PLANS
FIRST FLOOR PLENUM SYSTEM
CEILINGS 15′
WALLS ALL EXPOSED
WINDOWS 3′x 11′



COIL HEATING SURFACE, METHOD NO. 1 FIGURED FROM HEAT LOSS PRINCIPALLY

Assume a velocity of the air at the coils of say 750 ft. per minute, then (Carpenter, "Heating and Ventilating of Buildings," Par. 54) the number of heat units transmitted per sq. ft. per degree difference in temperature between the steam within the coils and the air surrounding the coils is 7. With the steam in the coils at 227° F. (5 pounds gauge) and the average temperature of the air around the coils at $(140+0)\div 2=70°$ F. the sq. ft. of heating surface in coils $=$ $2{,}966{,}502\div 7\ \ (227-70)=2700$. This is equal to (2700×3) 8100 linear feet of 1-inch pipe.

Check 1—In such a design as this the coils would be banked up from 16 to 20 rows deep in the heater. Under such conditions the heat transmitted per sq. ft. per hour per degree difference between the temperature of the steam and the entering air is 4.7 B.T.U. (Carpenter Par. 52) and we have square feet of heating surface $=$ $2{,}966{,}502\div 4.5\ \ (227-0)=2900=$ 8700 linear feet.

Check 2.—The total volume of the building is approximately 500,000 cubic feet. If 75 cu. ft. of space be allowed for each linear foot of 1-inch pipe in the coils (Sturtevant, "Ventilation and Heating," Page 33) we have $500{,}000\div 75=6666$ linear feet of pipe in the heater.

COIL HEATING SURFACE, METHOD NO. 2 FIGURED FROM AIR SUPPLIED FOR VENTILATION

In the above calculation for the heating surface the heat loss from the building was the principal consideration. This gave approximately 2.5 changes of air throughout the building per hour. In most cases a building heated in this way will give satisfaction, because the extreme temperatures assumed would seldom be needed and the air velocity could easily be increased to 1000 or 1200 feet per minute, thus giving opportunity to provide more air for the ventilation at a permissible reduction in temperature as it leaves the coils.

If, however, the ventilation of the building is an important factor, the safest method would be as follows:

Assume say four changes of air per hour in the entire building, which in this case is 2,000,000 cubic feet. This may be figured by individual rooms if desired. If this air is all heated from 0° F. it will carry from the building (at 70° F.) $2{,}000{,}000\times 70\div 55=2{,}545{,}454$ B.T.U. per hour. The total heat loss from the building would then be $2{,}545{,}454+1{,}483{,}251=4{,}028{,}705$ B.T.U.

The temperature of the air leaving the coils is therefore $4{,}028{,}705\times 55\div 2{,}000{,}000=110°$ F. With a required temperature of 110° F. for the air and a steam pressure of 5 pounds gauge we will need four sections of coils of four rows each, or 16 rows in depth in the heater. Under such conditions the efficiency of the heating surface is approximately $2\sqrt{V}\,(T-t)=2\sqrt{12.5}\,(227-0)=1544$, say, 1500 B.T.U. per sq. ft. per hour. Where $V=$ velocity of air in feet per second, $T=$ temperature of steam and $t=$ temperature of the entering air. From this is found the square feet of heating surface $=$ $4{,}028{,}705\div 1500=2686$. Then $2686\times 3=8058$ linear feet of coils.

Check 3—One quotation gives 200 linear feet of pipe for each 1000 cu. ft. of air per minute, at a velocity of 1500 ft. per minute at the fan and temperatures from 0° F. to 120° F. This gives $2{,}000{,}000\times 200\div(60{,}000)=6666$ linear feet.

CHANGES OF AIR NEEDED IN THE BUILDING

Assume a maximum of 1200 students to use the building at any one time and that each one will need 30 cu. ft. of fresh air per minute. This will require $1200\times 30\times 60=2{,}160{,}000$ cu. ft. of air per hour. $2{,}160{,}000\div 500{,}000=4.3$ changes of air per hour, which agrees fairly well with the assumed number of changes (4) previously mentioned.

ARRANGEMENT OF COIL SURFACE

Having given from the calculations 8,100 linear feet of coils, this may be divided, as a trial effort, into four sections of four rows to the section

with one section used as a tempering coil and three sections as heating coils. This gives 2025 and 6075 linear feet respectively in the heaters. If there are 16 rows of pipes, each row will contain 506 linear feet, or 168 sq. ft. of surface. With an air of velocity of 750 ft. per minute at the coils and a total of 1,156,935 cu. ft. of air passing per hour, the free area of cross section will be $1{,}156{,}935 \div (750+60) = 25.7$ sq. ft. The gross area, therefore, is approximately $25.7 \div 0.45 = 57$ sq. ft. This will require a single section heater of 7×9 ft., or a double section heater (sections set end to end) of 5×6.5 ft. Upon inspection of the heater sizes we find that the free area is satisfactory, but that there is not sufficient heating surface, since each row of coils of a 7×9 heater contains only about 116 sq. ft. of surface.

It will be necessary, therefore, to install 20 rows (five double sections of four rows to each section) and place say one double section as a tempering coil and four double sections as heater coils. With this arrangement the size of each section of a double section heater may be 5×7 feet, making 70 sq. ft. total gross area and approximately 28 sq. ft. of total free area. It also provides 67 sq. ft. of coil surface per single section row, making 134 sq. ft. of surface in each of the twenty rows. (Required 135 sq. ft.)

SIZE OF FAN

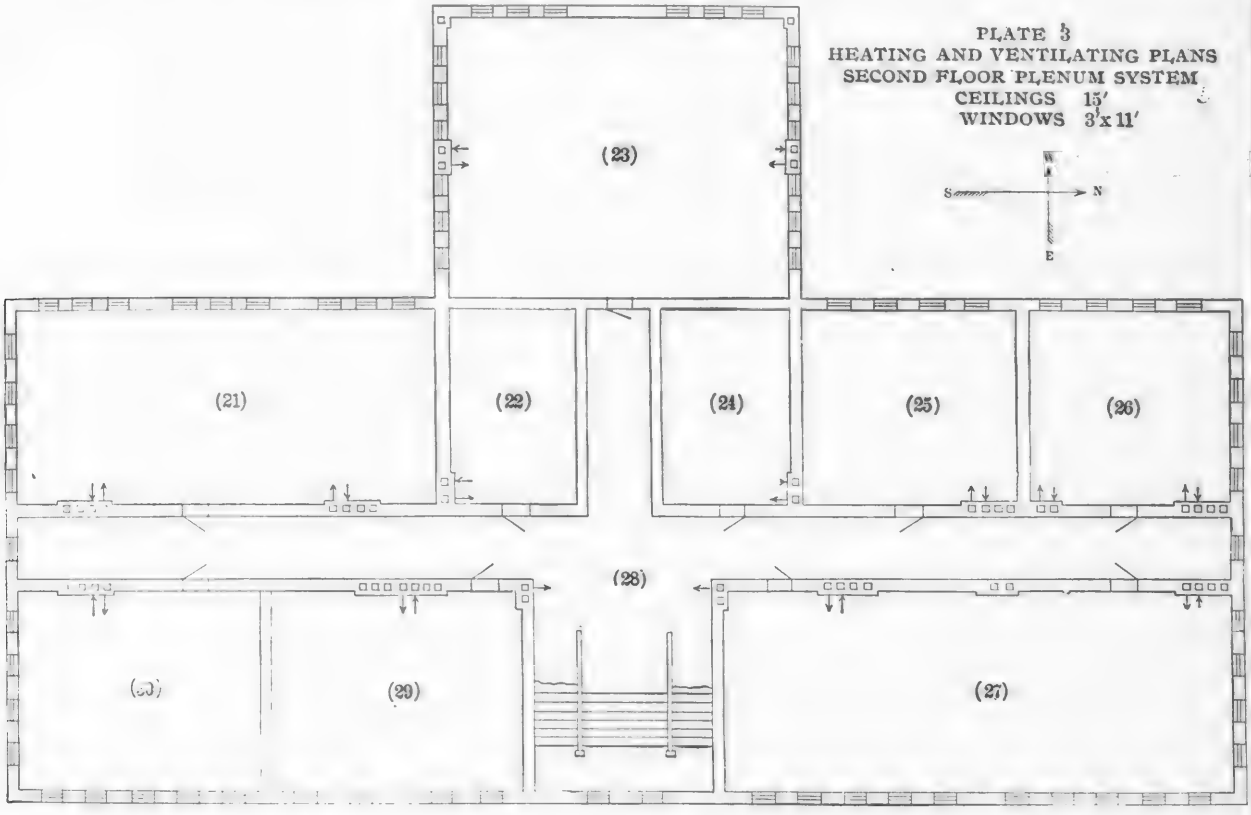
Select a steel housed paddle wheel fan direct connected to a low-pressure engine. Assume 250 R.P.M. as a maximum and the pressure of the air to be 1 ounce; then (Carpenter Par. 162) the diameter of the fan wheel is

$$D = \sqrt[3]{\frac{\text{cu. ft. of air per min.} \times 10}{4 \times 250}} =$$

5.8, say 6 ft.

From Sturtevant's "Mechanical Draft," Table 112, we find that a 6-ft. fan running at 250 R.P.M. can maintain a pressure of about 0.88 ounce. This might probably be safer, consid-

PLATE 3
HEATING AND VENTILATING PLANS
SECOND FLOOR PLENUM SYSTEM
CEILINGS 15'
WINDOWS 3'x11'



ering a possible increase in the air required for ventilation, if a 6.5-ft. fan were installed to run at say 200 R.P.M. The pressure maintained, however, would probably drop to less than 0.6 ounce, unless the speed were kept up to 250 R.P.M., in which case the pressure would reach 1 ounce.

Check—Let the velocity of the air at the outlet of the fan casement be 1,800 ft. per minute and assume that the efficiency of the fan delivery is 50%, then the peripheral velocity of the fan blades is 3600 ft. per minute and at 200 R.P.M. will give a 5.8-ft. fan wheel. This shows that the above sizes are ample.

livered to the building through conduits at a pressure of 30 pounds gauge (45 pounds absolute); that the steam is exhausted into the coils at a pressure of 5 pounds gauge (20 pounds absolute) and that the engine cuts off at 25% of the full stroke; then the mean effective pressure in the cylinder is

$$P = p\left(\frac{1+\text{hyp. log } r}{r}\right) - \text{back pressure},$$

$$P = 45\left(\frac{1+1.386}{4}\right) - 20 = 6.8 \text{ pounds}.$$

The sizes of the cylinders are obtained from

$$H.P. = 2\ PLAN \div 33000$$

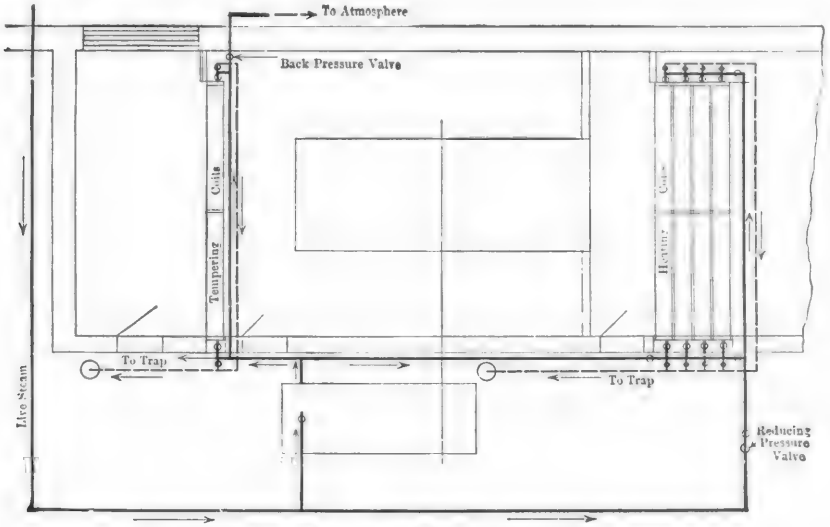


PLATE 4 PLAN OF PIPING CONNECTIONS

The fan outlet at 1800 ft. per minute air velocity is $1,156,935 \div (60 \times 1800) = 10.7$, say 12 sq. ft. A good rule used by some is to make the area of discharge $A = 2 \times$ diameter in feet, which in this case would be 12 sq. ft.

The double fan inlet will be (considering the area of inlet = area of outlet) about 3 ft. diameter.

HORSE POWER OF FAN.

At 250 R.P.M., a 6-ft. fan with a pressure of 1 ounce will require (Carpenter Par. 162)

$H.P. = D^5\ (R.P.S.)^3 \times 20 \div 1,000,000 = 10.9$, say 12.

SIZE OF ENGINE REQUIRED

Assume that the steam is taken from a central power plant and de-

$L.A = 12 \times 33,000 \div (2 \times 6.8 \times 250) = 117$.

If $L = 12$ in., then $A = 117$ sq. in. and $D = 12.2$, say 12 in.

AMOUNT OF STEAM USED PER HOUR IN THE COILS

The amount of heat given off from one pound of good dry steam in condensing from 5 pounds gauge to water at atmospheric pressure is $1183 - 212 = 971$ B.T.U. The amount of steam, therefore, needed per hour to supply the building with heat on a zero day is $2,966,502 \div 971 = 3055$ pounds, where only enough air is used to serve as a heat carrier; and $4,028,705 \div 971 = 4150$, where at least four changes of air per hour are required for ven

tilation. This means 1.1 pounds of steam per sq. ft. of heating surface per hour in the first case and 1.5 pounds per sq. ft. of heating surface per hour in the second case.

BOILER HORSE POWER NEEDED

If the engine uses 35 pounds of steam per horse power hour, or a total of 420 pounds per hour, and the heating value of the exhaust steam is only 75% of that of dry steam at the same pressure, then the exhaust steam will supply to the coils an equivalent of $0.75 \times 420 = 315$ pounds of steam per hour, leaving $4150 - 315 = 3835$ pounds of steam to be supplied direct from the boiler. The total dry steam therefore needed from the boiler for the plant will be $3835 + 420 = 4255$ pounds per hour, or approximately $(4255 \div 34.5)$ 123, say 125 boiler horse-power.

SIZE OF DUCTS

Assuming 2,000,000 cu. ft. of air to pass through the main heat duct *A* per hour at a velocity of 1800 ft. per minute, the duct will be approximately 20 sq. ft. in cross section, say $2\frac{1}{2} \times 8$ ft. The two main branches *B* will carry about 800,000 cu. ft. per hour each at the same velocity and will be 7+sq. ft. in area, or 2×4 ft. The same branches at *C* will carry about 400,000 cu. ft. per hour each at a velocity of say 1500 ft. per minute and will be 4.4 sq. ft. in area, or say $2 \times 2\frac{1}{2}$ ft. and the west branch *D* will carry about 300,000 cu. ft. at a velocity of 1200 ft. per minute and will be say $1\frac{1}{2} \times 2\frac{3}{4}$ ft.

The calculated duct sizes, of course, refer to the heat duct. The cold air duct need not be so large, because on warm days, when only tempered air is needed, the steam may be turned off from one or more of the heaters and the heat duct can then be used to furnish what otherwise would be required from the cold air line. On account of this flexibility it seems only necessary to make the cold air duct from one-half to two-thirds the cross sectional area of the heat duct. For convenience of installation, therefore, the former will be made of equal width to the latter and say one-half as deep.

Concerning the construction of the ducts, it is here (Plate I) represented as brickwork with some satisfactory division between the cold air and the hot air lines, and with a covering that will be suitable to the floors to be installed in the building. The former may be merely sheets of galvanized iron and the latter may be galvanized iron where a timber floor is used, or it may be *T* irons covered with brickwork and cemented if a concrete floor is used.

BY-PASS ARRANGEMENTS

In the plans as shown it is assumed that the coils will be set high enough to allow by-pass dampers to be installed beneath them. These dampers must be controlled from the engine room side and should have, say, two-thirds of the free area at the coils.

REGISTER SIZES

The net register was figured from an air velocity of 300 feet per mnute and the sizes of the registers (catalogue sizes) were estimated to be 1.6 times the net area.

STACK SIZES

The stacks were first figured for a velocity of 600 ft. per minute and then sizes were assigned to fit the laying of the brickwork such that the velocities varied anywhere from 300 to 600 ft. per minute.

All stacks should be fastened to a smooth surface on the inside and should have the tops corbeled to a curve so as to avoid a square or dead end.

DISCUSSION

PROFESSOR HOFFMAN—This paper is presented not to give you anything startling, but to show that the work from the standard of the heating and ventilating engineer is open to a rational basis for calculation.

Paragraph No. 2, heat lost from the building. I might have taken that from many formulas, but I selected the one given by Professor Carpenter which was discussed this morning. I found that in a building such as I have selected the heat loss from the walls and windows is 1,483,251 B. T. U. per hour; that is, assuming the air to come in at a temperature of 140° from the duct. The most important feature, I suspect, in the whole thing, is the estimation of the square feet in the coils and then the division of those coils into units. Possibly I have taken up more space on the coil end of it than upon any other, because I merely wanted to check to see how we were coming out.

Total heat loss, 2,966,502 B. T. U. Now, of course, to find the amount of air needed as a heat carrier, we can do it by individual estimates or by the entire lot, if we choose.

Method No. 1 and Method No. 2 represent merely the thing that we have been discussing this afternoon: first, whether we would figure the heating surface from the standpoint of just sufficient surface to supply the amount of air with heat necessary, because of the heat loss from the building, or whether we are going to take it from standard of heat supplied for ventilation. Method No. 1 does not count ventilation except as we supply air enough by accident. Method No. 2 takes in the subject of ventilation and is started with the number of cubic feet of air needed in the building per hour, so I work through both Methods Nos. 1 and 2.

We can figure out that the total number of square feet of surface is 2,700, where we are allowing that the air is at an average temperature at between zero, when it comes in, and 140°, as it goes out, or, we will say 70°. Hence in the formula, in Method No. 1, we have a total heat loss of 4,028,705 B. T. U. That gives us 8,100 linear feet of pipe in the heater, assuming that all the pipe is placed in one heater. As a check, in most buildings about this size, we would have the coils somewhere divided into rows, sixteen or twenty. I take it sixteen rows deep, and from Carpenter I found out that the average transmission setting the coils sixteen rows deep was 4.7 B. T. U.

After we have found the total number of cubic feet of air that we need, the next thing is to find the temperature at which the air will leave the coil. In the first place, I assume that temperature; in the second case, I assume the air and find the temperature.

Now, as a check to No. 2, one quotation says 200 linear feet of pipe will be installed. This makes 2,686 feet, showing that the theoretical or calculated heating surface in both cases runs higher than the amount stated or given by a couple of the standard forms.

Paragraph—Changes of Air Needed in the Building.—I assume four changes, which is near enough not to have any decided effect.

Paragraph.—Arrangement of coil surface. Having given the linear feet, 8,100, and divided this into four banks, of four rows to the bank, making sixteen rows in each, I found that the number of square feet of net area at the coil was sufficient, but the heating surface was insufficient.

There are two things necessary in proportioning the coils; first, the net area at the coils for the air to pass through; and, second, the square feet of heating surface per row. With an air velocity of 750 feet per minute this gave a quantity which was too small, and under a second condition it was changed, so that it brought what was desired. That is, instead, of putting four banks of four rows to a bank, I put in five rows of four rows to the bank.

Paragraph.—Size of the fan. In working out the size of the fan I found that a very good formula was given by Professor Carpenter.

For a fan outlet, I found that it gave about twelve square feet, and for a double fan inlet, about three feet in diameter. Then the calculation of the horse power of the fan is also from a very good formula of Professor Carpenter's, making the horse power in this case about twelve. The formula for the size of the engine I think you all understand.

Paragraph.—Amount of steam used per hour in the coils. This amount was found to be 4,150 pounds, where at least four changes of air per hour were requred for ventilation.

Of course when we attempt to calculate, for instance, the heating surface in the coil, we are ourselves subject to certain constants that have been found by the methods of experimentation; for instance, 7 B. T. U. per square feet of heating surface per hour. That means one square foot of heating surface on the first run of coils will transmit 7 B. T. U. under conditions of zero outside of 140° inside, and if we are taking the average condition where we are counting the number of coils entire, say sixteen or twenty, the transmission is cut off because the first row is much more valuable than the middle or the latter row. These constants I have assumed to be fairly accurate and with them I have worked out some of the most important features of the design.

MR. LEWIS—I think the practice I have had has been very closely in ac-

cordance with this. Possibly we get our boilers too large. We get them large enough to take care of poor draught, poor coal or poor fireman.

PROFESSOR ALLEN—In check No. 1, Professor Hoffman assumes the transmission to be 4.7 per square foot per degree. One thing that must be taken into consideration in a fan system is the rate of air passage through the coil. The amount of condensation depends upon the rate of air passage, and upon the depth of the fan coil. I have obtained as high as seven pounds per square foot, with zero outside and just two pipes deep. If you use very shallow coils in one place and sixteen deep in the other, you will have hot and cold spots, as the air comes through slowly in some places, in others rapidly, and there are unequal heating effects in the fan chamber.

A velocity of 750 feet per minute through the fan coil is rather lower than my practice. Possibly I have used too high speeds, a speed of 1,200 feet. Of course, I can readily realize that the lower the speed at the fan coils the less power will be required to drive the fan. The author figures the horse power of the fan on the basis of one ounce pressure. That occurs to me to be rather high on an ordinary building. My experience has been that it is not necessary to use much over 3/10 to ½ ounces for overcoming resistance in the building.

MR. LEWIS—My experience has been to use a velocity of 1,000 to 1,100 feet; in some instances, 1,200 feet through the coils.

MR. LARSEN—I have used 1,200 feet, as near as I could get it.

MR. LEWIS—Professor Carpenter gives a table of condensation which I have never been able to prove was right, but I have used it for several years. I think he gives 93/100 pounds per square foot per hour condensed, with entering temperature zero, with coils twenty rows deep. So I think figuring the amount of condensation per square foot per hour is good practice.

In a blast steam plant, instead of having a tempering coil drawing air and getting two temperatures, one about 160° and one about 130°, I think it is more economical to put all the coils in one group and blow through them and then temper the air by a double damper, the same as admitting air to one room in a building. In the operation of the plant through much of the year the six rows of pipe put in, practically one-third of the heating surface, are too much to heat the air to 70°; they heat it to 100°; and therefore the dampers are held open, taking longer to warm the air.

MR. LARSEN—My experience in Duluth has been the reverse, possibly on account of our having colder weather than you have been used to. I find by putting my coils all into one bank, and dividing my plenum chamber and using a double mixing damper at the flue, that when the thermostat throws the air over, the cold air that comes into the room immediately comes down and strikes the pupils. It is not up above the breathing line where it ought to be, therefore I have placed my tempering coils above the fan to heat to 60° or 65°; and that passes the air from the main coils into the lower part of the plenum chamber, and when the room goes to 70° or over, the damper is turned and it admits air at 60° or 65°, and does not strike the pupils at the breathing line so soon.

VICE-PRESIDENT MACKAY—Is there anything in the air striking the fan at a very low temperature? You take in air sometimes 10° to 20° below zero.

MR. LEWIS—I imagine you would throw a little more air by the fan. The fan is possibly working at a little better efficiency.

PROFESSOR ALLEN—The objection I have always had to putting very cold air on the fan is that it makes the bearings very cold and in some cases the oil gets sticky, which might increase the fan friction.

SAMUEL KAUFFMAN—I would like to ask Mr. Lewis where he would put an air washer, if you put one in with the system he has described.

MR. LEWIS—I could not use it with that system. It would freeze the water.

MR. OLDACRE—Could you not put the washer between the heating and tempering coil on one side of the fan?

MR. LEWIS—There is very often a space of three feet left between the heating and tempering coils when they are placed on the side of the fan. To some extent that is similar to this arrangement. I have never seen an air washer put on the blast side of a fan. I do not know any reason why it would not work, except that there would be greater condensation and the air would be more moist.

PROFESSOR ALLEN—I have always put the air washers between the tempering coils and the fan and heated the air, for this reason principally: If your air is going into the room, if the room is colder than the air, the air will carry too much moisture and there will be precipitation of moisture in the room. If you are going to put it into a room warmer than the air, you will have no difficulty. I have in mind one case where we washed the air for a restaurant which has no outside windows, and holds about 300 people. It is a basement restaurant, but there we never had any difficulty from the deposition of moisture from the fact that our air that comes in is cooler than the restaurant. Even in zero weather we are cooling the restaurant. But when you are using washed air in a plant that is colder than the air, you have to put in a heating coil.

VICE-PRESIDENT MACKAY—The idea is that the air washers carry considerable moisture in the process of washing and this air absorbs it, and unless there is some way of eliminating the moisture it is precipitated into the rooms as Professor Allen points out. These various devices are all good in their way.

Morning Session, July 19

The first paper read at this session was entitled:

The Combined Vacuum and Pressure System of Steam Heating

By George D. Hoffman

(This paper was published in our July issue)

DISCUSSION

WILLIAM G. SNOW—I would like to ask Mr. Hoffman if he can give us any idea what would be considered a reasonable limit during which a range of temperature such as he mentions could be maintained.

MR. HOFFMAN—I know nothing about this matter personally. I have been told that the period depends first upon the tightness of the job and second upon the coldness of the weather. Generally speaking, from ten to twelve hours under vacuum is considered very good practice; or, in other words, to get up a steam pressure twice a day.

E. F. CAPRON—In making this test, was the gas supply controlled by an automatic regulator?

MR. HOFFMAN—No, sir; we had a tested meter in the same roow with the apparatus and took periodical readings.

MR. CAPRON—That shows a great saving in the consumption of gas. Could you regulate the coal to make the same saving in consumption? Would the coal burn up so rapidly that you could not shut it off as rapidly as with gas?

MR. HOFFMAN—You cannot.

THEODORE WEINSHANK—Would this system be applicable where exhaust steam is used?

MR. HOFFMAN—We have never tried the system on exhaust steam heating, owing to the oil and grease interfering with the operation of the valves, but I have never been able to figure it out that it would not be applicable to exhaust steam heating, provided you had some means of controlling the return of air to the radiator after it was once expelled. Of course, in that case, you would either have to have sufficient back pressure on your engine to exhaust the air by pressure instead of by suction, or else you would have to have your live steam connected up in such a way as to get this necessary pressure.

We have an installation in New York on a seven-story apartment building that has over 300 rooms in it. A recording-pressure gauge on the boiler showed that only twice in 24 hours did the boiler ever go to pressure. In that particular case there are over 160 rooms in the building that are heated by risers running up through the rooms and requiring, therefore, only one control on the top of each riser. There are 24 of those risers and 24 controlling valves. The vacuum equipment cost about $300 and the owner has stated that he is willing to make an affidavit that his coal saving, in one winter, was over $400, so that the vacuum proposition paid for itself in that time and the owner had $150 to spare.

MR. DONNELLY—Mr. Hoffman says that when the radiator was 212° he was burning 60 feet of gas per hour. When the radiator was 201° he burned 50 feet of gas per hour. When the radiator was 157° he burned 24 feet of gas per hour, which was less than one-half of the original amount of fuel. According to all data I have been able to get, a radiator at 180° will give off fully two-thirds the amount of heat that a radiator at 212° will give off. So this gives off two-thirds the heat with one-half the fuel. I cannot reconcile this data with the facts.

PROFESSOR J. H. KINEALY—I do not think the method of test of Mr. Hoffman needs to be amended. I see no reason why the paper should not be substantially correct, even though the amount of heat given out by the radiators should be out of proportion to the amount of fuel, as Mr. Donnelly says. I think that the vacuum system is the thing to be commended, and any method by which we can adapt a vacuum system of heating to ordinary houses is one that will be of benefit to all.

PROFESSOR WARREN S. JOHNSON—On the question of conservation of energy to heat a room, it does not make any difference in what way you get the units of heat. It takes so many units of heat to heat a room. I cannot see what difference it makes whether the heating surface is 180°, 250 or 300°, provided so many units of heat are put into the air of that room, or how the expense can be different in one case than in another.

PROFESSOR STORM BULL—There are certain advantages connected with the vacuum system which I recognize, and I think everybody recognizes. That it should take less heat to heat a room under the vacuum system I am positively certain is not so. You may possibly use a smaller radiator; you may possibly use exhaust steam when you could not do it under ordinary circumstances, but if you have steam of one pound or five pounds or ten pounds, as Professor Johnson says, it takes as much to heat. It is possible in small individual plants that if you fire in the evening, with a perfect vacuum system, the steam will certainly last longer during the night than it would without the vacuum system, and in that respect it would be an economy, but not because the pressure is low.

PROFESSOR HOFFMAN—One of the chief sources of heat loss in any building is the irregular temperature in the room due to the excessive heating of the radiator and the consequent opening of the doors and windows to reduce the temperature.

JAMES H. DAVIS—Regarding the partial heating of a radiator under a vacuum, I have seen a number of instances where, for long periods of time, only portions of the radiator were heated and that was due to limiting the amount of steam that went into the apparatus, and I think it quite possible to so control your damper in a vacuum apparatus that the amount of steam generated will only partially fill the apparatus and radiators.

G. D. HOFFMAN—I quite agree with Professor Kinealy that the lower temperatures of steam are greater heat distributers than the higher temperatures. There are two factors in that question which make me lean to that opinion; one is that the higher temperature in the radiator, the more repellant the radiator is to air circulation over it, and as air is only heated by actual contact with that heated surface, if the radiator is very hot it has a tendency to repel the air traveling over its surface, and therefore does not give as much heat.

VICE-PRESIDENT MACKAY—I think Mr. Hoffman's phenomena of a radiator repelling the air refers to some particular type of radiator.

PROFESSOR BULL—I want to disclaim any intention of saying that there is no economy in the vacuum system. I did not state that. Still, I would like further to emphasize the fact that I have not yet heard any explanation to show where the real economy comes in.

Mr. Schlemmer's paper on "Formula for Pipe Sizes in Hot Water Heating," together with the discussion it brought out; also the discussion of the topics on the programme, including an additional topic on the subject of air washing, will be published in the September issue of THE HEATING AND VENTILATING MAGAZINE.

Glue and gelatine require low temperatures for drying purposes. Knit goods in the piece are dried by internal application of heated air under pressure which distends the piece; the air escaping through the meshes. Cotton, wool and the like are spread upon beds formed by covering with netting enclosed boxes into which the hot air is discharged and from which it can only escape through the material above. The materials now dried by hot blast are legion; asbestos, blood, bricks and clay, clothespins, eggs, leather, malt, milk and gunpowder, hair, soap, stove linings, sweet corn, yarns and a thousand other products of our industries depend upon the process for their successful production.

CORRESPONDENCE

Supply Mains and Risers for One-Pipe Steam Heating

Editor HEATING AND VENTILATING MAGAZINE: Which is the best way to lay out risers for a steam job, one pipe, on a four- or six-story building? Is there any simple rule by which it can be figured? Will a riser take care of as much radiation in a building as the steam main in the cellar? Have you a steam chart relating to the amount of radiation that can be placed on steam mains and risers of various sizes in one pipe work? M. J. H.

Yonkers, N. Y.

The accompanying table is made up from figures secured from actual practice and has been found trustworthy. It will be noted that risers do not carry quite as much surface as mains of the same size.

TABLE SHOWING AMOUNTS OF RADIATION CARRIED BY SUPPLY MAINS AND RISERS IN ONE-PIPE HEATING FOR PIPES RANGING FROM 1¼ TO 6 INCHES IN DIAMETER:

Supply Mains 1 pipe.	Risers 1 pipe.	Size of pipe.
70	50	1¼
150	120	1½
300	250	2
500	400	2½
750	700	3
1,400	1,400	4
2,400		5
4,000		6

A Friendly Word

HEATING & VENTILATING MAGAZINE Co., New York:

I have the sample copy of your magazine recently sent me and find so many good things in it that I desire to have it for my department library. I am, therefore, enclosing $1.00, to cover subscription for one year, and shall be glad to have you send same to the School of Mechanical Engineering, Vanderbilt University.

CHARLES L. BROWN,
Professor Mechanical Engineering.
Vanderbilt University, Nashville, Tenn..

Robert W. Kyle Co., Wheeling, W. Va., steam heating Virginia theatre; also heating and plumbing McClure Hotel Annex, at Wheeling, for $15,000; also heating system for Jefferson County Infirmary at Steubenville, Ohio.

THE HEATING AND VENTILATING MAGAZINE

Vol. 4 August, 1907 No. 8

PUBLISHED MONTHLY AT
1123 BROADWAY, NEW YORK
BY THE
HEATING AND VENTILATING MAGAZINE CO.

A. S. ARMAGNAC, EDITOR

European Representative:
AMERICAN PUBLICATION BUREAU, 31, Overton Road, Leicester, England

Subscription, - - - - - $1.00 per year
Foreign countries, - - - - 1.50 " "

Manuscripts submitted for publication must in every case be accompanied by postage; otherwise they will not be returned.

THE mayor of Milwaukee, in his address of welcome to the heating engineers on the occasion of their recent meeting in that city, called attention to an important feature of all such gatherings when he referred to the inability of the average citizen to follow the technical discussions. This sometimes may be rather fortunate than otherwise, but in the case of such papers as those by Mr. E. R. Swan on "Heating and Ventilating Cars," and by George D. Hoffman on "The Combined Pressure and Vacuum System of Steam Heating," a wider knowledge of the ideas they contain on the part of the average traveler and house builder would prove an advantage in every way. If the general public could understand, for instance, that the proper ventilation of railroad trains may be done successfully and at comparatively little expense, such a knowledge would soon prove a formidable weapon in securing this object.

What is needed is a department through which the society's papers of public importance may be edited and rewritten from a popular standpoint. It would surprise many to know how wide a circulation such papers would have.

THE course of a technical discussion on a given topic or paper can not always be foreseen and frequently leads into a talk most interesting to all but not bearing directly on the original subject. This has been a noteworthy feature of the professional meetings of the heating engineers, and has lent an interest to their discussions much beyond that connected with the topics themselves. A recent instance of this was the discussion of air washers at the society's summer meeting, the matter coming up in connection with a discussion of the hot blast system of heating. So much interest was aroused that a special place was given the topic of air washers at another session, with the result that an exhaustive consideration of this apparatus was had.

FOLLOWING previous announcements made in these columns regarding the progress of the efforts to introduce among the steam fitting trade the so-called "stamped order" calling for the replacement of defective parts on the part of manufacturers, we are advised that such orders are not being received by the trade, at least in the East, but are being returned to the senders with word to the effect that the stamped condition must be omitted before the order can be filled. This must not be taken to infer that the manufacturers are not willing to replace parts found defective in manufacture, but it is rather a refusal on their part to bear the cost of what they term "consequential" damages.

Central Heating and Ventilating Plant of the Stock Exchange at Budapest*

II. CALCULATION OF LOSS OF HEAT

By Charles Knuth, Jr.

The calculations for loss of heat are made generally according to Rietschel's tables, and are here converted nto English measures as follows:

Suppl. = cubic feet heated × 16 × 0.018 = cubic feet heated ÷ 3.

Assumed lowest temperature of non-heated cellar and other portions of building permanently non-heated = 32° F. Vestibule, corridors, etc., non-heated and at frequent intervals in direct contact with external air = 23° F. Air spaces between roof and ceiling of rooms; for metal and slate roofs, t = 14° F., for brick roofs, concrete roofing, t = 23° F.

There is a table to be filled out as following example shows (Table I).

LOSS OF HEAT THROUGH WALLS IN B.T.U. PER SQUARE FOOT PER DEGREE F. DIFFERENCE PER HOUR

Thickness of wall in ins.	1	2	3	4	5	6	7	8	12	18	24	30	36	42	48
Plaster wall.	0.65	0.58	0.51	0.45	—	—	—	—	—	—	—	—	—	—	—
Conc. wall.	—	0.64	0.58	0.53	0.49	0.45	0.43	0.40	—	—	—	—	—	—	—
Outside wall, brick.....	—	—	—	—	—	0.45	—	—	0.30	0.24	0.20	0.16	0.14	0.12	0.11
Inside wall, brick.....	—	—	—	—	—	0.40	—	—	0.28	0.20	0.16	0.14	0.12	0.11	0.10
Brick, without plaster.	—	—	—	—	—	0.48	—	—	0.34	0.26	0.22	0.18	0.16	0.14	0.12

LOSS OF HEAT THROUGH OTHER BUILDING MATERIALS IN B.T.U. PER SQUARE FOOT PER DEGREE F. DIFFERENCE PER HOUR.

Single window	1.06
Double window	0.76
Double glass	0.60
Doors	0.60
Wooden beam as ceiling	0.08
Ceiling, concrete	0.20
Ceiling, wooden planked	0.12
Tar, paper and slate	0.44
Concrete with tar and wood	0.26
Iron (corrugated)	2.00
Stone floor without cellar	0.28

SUPPLEMENTS FOR SURFACES EXPOSED

Aspects, East and W	10%
Aspects, N.E., N.W., N	20%
Wind	10-30%

SUPPLEMENT TO TOTAL LOSS OF HEAT

Height, 12-15 feet	10%
Height, 15-24 "	15%
Height, 24-30 "	20%
Height, 30-36 "	25%
Over 36 feet for every 3 feet add	5%
Ground floor	10%

Supplement caused by interruption of heating, assuming that the room is cooled down by 16° F. and has to be heated up in one hour.

RIETSCHEL'S COEFFICIENTS

After having calculated the losses of heat the radiating surface was determined by converting Rietschel's coefficients into English measure in the following way.

K = B.T.U. per degree difference steam and air per square foot surface per hour.

Velocity of air assumed according to natural upwards motion.

K FOR RADIATORS, SMALLEST SPACE BETWEEN SECTIONS NOT LESS THAN $\frac{3}{4}$"

(Low pressure Steam Radiator.)

	K.
1 Section	2.3
2 Sections	1.9
3 Sections	1.8
4-6 Sections	1.7
More than 6 Sections	1.6

*From a paper read before the Institution of Heating and Ventilating Engineers, London, England, June 25, 1907.

TABLE I—LOSS OF HEAT IN ROOMS

(Translated from Rietschel's Treatise on Ventilating and Heating).

Room on Ground Floor. Height of Room, 14 feet.

No.	Room: Name	Room: Length, feet	Room: Width, feet	Room: Height, feet	Room: Cubic contents feet	Cooling Surface: Name	Cooling Surface: Aspect	Cooling Surface: Length, feet	Cooling Surface: Height, feet	Cooling Surface: Surface, feet	Cooling Surface: Number of	Cooling Surface: Deduct	Cooling Surface: Calculate	Thickness of wall, feet	Temp. Fahrenheit: Inside	Temp. Fahrenheit: Outside	Temp. Fahrenheit: Difference	Co-efficient	Amount of Heat: Loss	Amount of Heat: Gain	Amount of Heat: Total	Supplement: Considering aspects	Supplement: For interruption of heating	Total: Loss of Heat units per hour	Notice
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	Office	10	15	14	2100	*w*	N	5	9	45	1	—	45	—	68	−4	72	0.46	1490	—	—	298	—	—	
						ow	N	15	14	210	1	45	165	2	68	−4	72	0.2	2376	—	—	475			
						d	—	4	7	28	1	—	28	—	68	72	−4	0.6	—	67	—	—	—	—	
						iw	—	10	14	140	1	28	112	1	68	72	−4	0.28	—	125	—	—	—		
						d	—	4	7	28	1	—	1	28	68	60	8	0.6	134	—					
						iw	—	15	14	210	1	182	28	2	68	60	8	0.16	233	—					
					2100														4233	192	4041	773	700	5514 + 10% = 6065 + 10% at 5514 = 6616	

All doors, 4 × 7 feet; windows, 5 × 9 feet.

No ventilation assumed. w = window (double), o.w. = outside wall, i. w. = inside wall, d = door.

Column 24 = Col. 6 divided by 3, assuming that room cooled down from 68° to 50° F., and had to be heated up during one hour.

Column 25 = Col. 22 + Col. 23 + Col. 24 + 10% for ground floor + 10% for height being 14 feet.

The ground floor suppliment is not taken from Rietschel's tables, but experience showed it to be correct. All rooms were exactly calculated with this method, ventilation always being calculated separately. After the losses of heat due to transmission and losses of heat due to ventilation have been calculated a table of the following kind has been filled out.

TABLE II—RESULTS OF CALCULATION, HEATING AND VENTILATING OF ROOM DESCRIBED IN TABLE I

Room			British Thermal Units						Ventilating Ducts						
Name	Temp. °F.	Contents, Cu. ft.	Transmission at — 4°F.	B.T.U. Cu. ft., hour	Transmission at 14° F.	Fresh air Cu. ft., per hour	B.T.U. for heating air from 14° to 68°	B.T.U. for heating and ventilating	Cu. ft. air per hour	Velocity. Feet per second	Section of air duct, sq. ft.	Register, sq. ft., calculated	Register designed at top	Register designed at floor	Notice
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I. Floor.															Col. 6 =
Stock Exchange.	68	706,000	420,000	0.59	314,000	1,020,000	991,440	1,305,440	1,020,000	6.2	45.7	57.5	8 24″×35″ 1 19″×29″ 1 16″×24″	6 24″×35″ 1 19″×29″ 1 19″×24″	Col. 4 × (inside temp. − 14) divided by (inside temp. —) − 4 = Col. 6 × $\frac{54}{72}$ Col. 9 = Col. 6 + Col. 8. Col. 14 rounded up to suit models.
Change	68	10,500	15,500	1.47				15,500	10,500	6.2	0.47	0.71	9″×12″		
Secretary	68	5,500	8,000	1.46				8,000							
Entrance Hall	68	5,500	8,000	1.46				8,000							
Physician	68	5,600	8,300	1.48				8,300	5,600	6.2	0.25	0.38	9″×12″		
Corridor	60	22,500	29,000	1.29				29,000							
Buffet	68	22,400	20,200	1.11	15,150	102,000	99,144	114,294	102,000	6.2	4.57	6.90	24″×35″	24″×35″	
Conversation	68	26,500	26,400	1.00	19,800	141,000	132,000	151,800	141,000	6.2	6.37	9.6	19″×29″	19″×39″	
Smoking room	68	22,500	20,500	1.09	15,400	102,000	99,144	114,544	102,000	6.2	4.57	6.90	24″×35″	24″×35″	
etc., etc.															

K: wrought iron heating surface. Pipe in form of coils up to the height of 3 feet. The coils do not touch. Space between them at least equal to size of pipe.

Pipe up to $1\frac{1}{4}$" outside diameter. ..... K = 2.5
Pipe over $1\frac{1}{4}$"..... K = 2.2
Same coils but more than 3 feet high:
Pipe up to $1\frac{1}{4}$" outside diameter..... K = 2.2
Pipe over $1\frac{1}{4}$"..... K = 1.9
System of pipes, horizontal or vertical:
One row..... K = 2.3
Two rows..... K = 1.8
Three rows..... K = 1.6

Using these coefficients the heat given off by radiating surfaces was calculated as follows:—

1. Radiators standing in room.....t = 68° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.
   K = (212 + 194 ÷ 2 − 68) 1.6 = 216 B.T.U. per sq. ft. per hour.
2. Radiators in corridors.t = 60° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.
   K = (212 + 194 ÷ 2 − 60) 1.6 = 230 B.T.U. per sq. ft. per hour.
3. Radiator as tempering heating chamber:
   Air inlet side.....t = 14° F.
   Air outlet side.....t = 50° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.
   K = (212 + 194 ÷ 2) − (14 + 50 ÷ 2) 1.6 = 274 B.T.U. per sq. ft. per hour.
4. Radiator in heating chamber:
   Air inlet side.....t = 50° F.
   Air outlet side.....t = 113° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.
   K = (212 + 194 ÷ 2) − (50 + 113 ÷ 2) 1.6 = 195 B.T.U. per sq. ft. per hour.
5. Coils in tempering heating chamber (more than 3 feet high):
   Air inlet side.....t = 14° F.
   Air outlet side.....t = 50° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.
   K = (212 + 194 ÷ 2) − (14 + 50 ÷ 2) 2.2 = 376 B.T.U. per sq. ft. per hour.
6. Coils in heating chamber:
   Air inlet side.....t = 50° F.
   Air outlet side.....t = 113° F.
   Steam inlet.....t = 212° F.
   Return pipe.....t = 194° F.

TABLE OF K FOR DIFFERENT VELOCITIES OF AIR

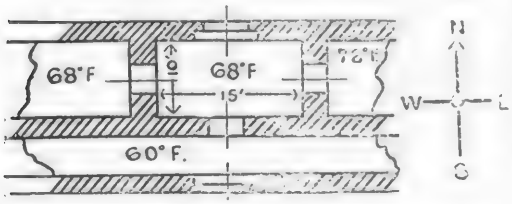
One or more rows wrought iron parallel pipes up to ¼", and having an air space of $\frac{3}{16}$". Air passing at right angles to pipes.	B.T.U. given off per hour by one square foot at a difference of temperature of one degree Fahrenheit between mean temperature of steam and mean temperature of air before and after passing if greater velocity of air in feet per second is:—									
	2	4	6	8	10	12	14	16	18	20
One row—K....	1.90	3.15	4.12	4.90	5.60	6.25	6.85	7.30	7.80	8.30
$\frac{V}{K}$....	1.05	1.27	1.45	1.63	1.79	1.92	2.04	2.19	2.30	2.41
Two rows—K...	1.84	3.00	3.94	4.70	5.36	5.96	6.56	7.03	7.50	7.99
$\frac{V}{K}$....	1.09	1.33	1.52	1.70	1.85	2.02	2.14	2.27	2.40	2.50
Three rows—K.	1.76	2.85	3.77	4.50	5.13	5.68	6.28	6.76	7.20	7.62
$\frac{V}{K}$....	1.14	1.40	1.58	1.77	1.94	2.11	2.23	2.38	2.50	2.62
Four rows K....	1.70	2.70	3.60	4.30	4.90	5.40	6.00	6.50	6.90	7.25
$\frac{V}{K}$....	1.18	1.48	1.66	1.86	2.03	2.22	2.33	2.46	2.60	2.76

K = (212 + 194 ÷ 2) — (50 + 113 ÷ 2) 2.2 = 268 B.T.U. per sq. ft. per hour.

The heating surface has been determined according to these coefficients.

TWO EXAMPLES

First floor of Stock Exchange: Total B.T.U. = 1,305,440. Half of this amount assumed in the tempering coils and half of it in heating chambers, then tempering coils have to cover 1,305,440 ÷ 2 = 657,720 B.T.U. per hour.



PLAN OF ROOM CHOSEN FOR CALCULATIONS

Heating surface = 657,720 ÷ 376 = 1,750 sq. ft. coils.

Heating chambers have to contain

1,305,440 ÷ 2 = 657,720 B.T.U. per hour.

K = 268

heating surface = 657,720 ÷ 268 = 2,454 sq. ft. coils.

It can be seen that for the same amount of heat and assuming these special conditions of temperatures we want about 40% more coils at the heating chambers than at the tempering coils, always assuming no forced draught.

If the velocity of air is greater than according to natural upwards movement, other coefficients have to be used, which are as given on previous page, according to Rietschel's tables.

At the building of the Stock Exchange the heating chambers were designed to require a velocity of 8 ft. per second to give the air change provided, therefore using two row pipe systems, K = 4.7 B.T.U. per degree difference per square foot per hour, and K = (212 + 194 ÷ 2) — (50 + 113 ÷ 2) 4.7 = 573, and instead of 2,454 square feet, there were only required 657,720 ÷ 573 = 1,140 square feet.

REITSCHEL'S FIGURES FOUND CORRECT

It seemed important to dwell at some length on the subject of determining the loss of heat and the calculation of the heating surfaces, and I was to some extent stimulated to this step by the paper read by Mr. Walter Jones last year at the summer meeting of the American Society of Heating and Ventilating Engineers. This paper contained an interesting comparison of different methods used. As far as I am informed, most continental engineers calculate with Professor Rietschel's coefficients and methods, and, as far as my practice goes, the results are sufficiently good.

In the building we are considering there was not a single room in which the guaranteed temperature could not be kept. The rules were tried for the mild climates of Hungary at the port of Fiume, where the temperature does not go below 18° F., and they were tried for buildings in the Carpathian mountains, where the temperature is sometimes minus 36° Fahrenheit, and where these rules proved sufficiently correct.

HEATING OF A GLASS HOUSE

But I know also two indirect proofs for the usefulness of these rules, taking two examples where the heating surface was calculated correctly and yet the heating effect was not satisfactory. One was a big glass-house at Kassa. It was not possible to heat it up the first winter. To prove that the heating apparatus gave a certain amount of heat, a regular boiler test was made. The coal and its heating value were measured, the temperatures of water and the CO_2 were determined, and it was shown that the stipulated heating effect could be reached, yet the houses were not hot enough. I assumed the coefficients to be correct, and as sufficient heating units were produced by the boiler the fault was located in the puttying of the glass. This was improved at a cost of about £40, and next year only two-thirds of last year's coal was used and the glass-house could be heated throughout. In this case the glass was wrong, because it allowed too great an exchange of air.

ROOMS HAVING SEVERE EXPOSURE

The second case was similar. Two out of 110 rooms could not be heated, although there was more heating surface in the room than necessary according to the tables. The rooms were corner ones facing the Danube, exposed to the winds and in addition having a big balcony door. It was contended that the windows and door could not be improved, though on cold and windy days a match was nearly blown out at the cracks of the window, therefore for such exceptional cases the supplement may sometimes prove not to be sufficient, and in those cases the practical experience of the engineer must come to his aid. For this case the heating surface was increased about 30%. As these are exceptions they prove the rule.

The chief aim is to consider all circumstances in order to distribute the heating surfaces at right places and right sizes. To overheat one room is just as dangerous a fault as to underheat another.

Telethermometer

The telethermometers used were designed by Dr. Koepsel and are manufactured by G. A. Schultze, of Berlin.

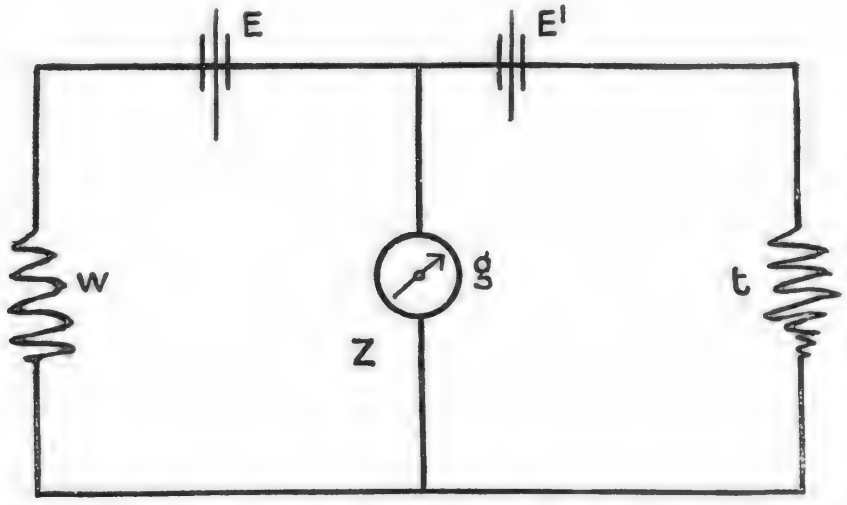
The idea of the system is based on the measuring of differential action of two electric currents, one of these is constant, the second varies with the variation of resistance due to variation of temperature.

E and E' in (see fig.) are two electromotoric forces with small inner resistance; resistance, w = constant, resistance of t = function of temperature, g = galvanometer with resistance g, Z = electric current flowing through galvanometer. For this scheme according to Kirchhoff's law we can write

$$Z = \frac{Et - E'w}{g(t + w) + tw}$$

If

$$E = E'$$



SKETCH SHOWING SCHEME OF TELETHERMOMETER USED FOR INDICATING TEMPERATURES AT VARIOUS POINTS OF HEATING SYSTEM

which condition can easily be reached with accumulators, this equation can be written

$$Z = \frac{E(t - w)}{g(t + w) + tw}$$

or in words, current in galvanometer is nearly proportional to difference of resistance. Small variation of t causes great variation of Z. It can be arranged for instance that a variation of 10% at t causes a variation of 80 to 90% of Z. This sensitiveness makes the apparatus useful to measure small differences of temperatures.

Resistance w is made of constantan wire and resistance t is made of nickel wire, which has a high co-efficient of temperature.

One galvanometer can be used for any number of thermometers by inserting a commutator. At the stock exchange building there are two galvanometers, each serving eight thermometers. The galvanometer gives readings of degrees directly on the dial.

If we call sensitiveness of a thermometer the time which elapses until thermometer shows half of the real sudden drop of temperatures, the galvano-electric telethermometer has the sensitiveness of 13 compared with 130 of a good mercury thermometer, that is, a sensitiveness 10 times as great as the mercury thermometer. For instance, a thermometer in a room shows 68° F. It is heated to 100° F. We have to note the time which passes till the thermometer shows.

$$68 + 32 - \frac{32}{2} = 84^\circ \text{ F.}$$

If we repeat the experiment by heating the thermometer up to 132° F. and note the time which passes till the thermometer shows

$$68 + 64 - \frac{64}{2} = 100^\circ \text{ F.}$$

we shall find nearly the same time as in the first case. The time is, with the galvanometer, about 10 seconds and with a mercury thermometer about 130 seconds. For special cases the sensitiveness can be augmented.

These thermometers have been working satisfactorily for two years.

Typical Franchise for Central Station Heating Company

Some idea of the scope of the purposes and privileges sought by the central station heating companies that are becoming so numerous in the Middle Western cities may be gained by reference to the proposed franchise sought by the Minneapolis Heating & Transmission Company from the city of Minneapolis. Among other things the franchise contains the following provisions:

"Permission and authority is hereby granted the Minneapolis Heating & Transmission Company, a corporation organized under the laws of the state of Minnesota, its successors and assigns, for the term of twenty-five years, to construct, acquire, maintain, extend, repair, operate, lease and let, underground conduits, subways, pipes and conductors, manholes, laterals, feeders, service pipes, appliances and all connections and appurtenances necessary or convenient thereto under the surface (with proper manholes and entrance ways on the surface) of the streets, avenues and alleys within the city of Minneapolis, for the purpose of furnishing, distributing, transmitting and delivering heat for heating purposes, mail and express matter, and general and special merchandise; also giving and granting to said company, its successors or assigns, the further right to lease and let space and privileges therein for other purposes for public or private use and to collect the proceeds from any such rentals for its own use and benefit, within the city of Minneapolis; said underground subways, conduits, pipes and conductors, to be constructed at such depth beneath the surface of the street as will not interfere with permanent improvements in the street, such as pavement, curb, gutter and sidewalk, and at such depth as will not interfere with any water or other pipes or sewers or any cables or conduits, either public or private, that are now in the streets, avenues or alleys of said city; provided, however, that no such underground subways or conduits when completed shall exceed in size a depth or perpendicular height of seven feet six inches and a width of six feet, inside dimensions.

The ordinance also provides that:

The city shall have 144 square inches of space for its wires free of charge and the preference over all other applicants for rental space.

This ordinance is not exclusive, and the enfranchised company shall not make any consolidation with or sale to any similar company without the approval of the city council.

The company shall pay the city a tax on gross receipts from all sources in the city of 2 per cent. for the first five years, 3 per cent. for the second five years, 4 per cent. the third five years, and 5 per cent. thereafter.

The maximum rates to be charged by the company are subject to revision by the city council at any time ten years after the acceptance of this ordinance, and thereafter not oftener than once in five years. It is provided that no rates shall be fixed which will prevent the company's earning an annual net profit of 8 per cent. on the capital invested. It is provided further that no rate shall be revised except upon the petition of 50 per cent. of the patrons of the company.

The company may drain its tunnels into the city sewers after obtaining the permission of the city engineer.

The company, after the publication of this ordinance, shall file a written acceptance thereof and a bond for $10,000 as a guarantee of good faith, and begin work in six months and expend $100,000 in one year's time."

A New Departure in Cooling and Humidifying Textile Mills

By W. H. Carrier, M. E.

II

You have been told that the fan system as employed for heating purposes in cotton mills is an attractive proposition on paper, but does not work out well practically. In one respect I must agree with that writer. The fan system as heretofore applied does successful heating, but is disastrous to the humidity conditions in the mill. The reason for this is apparent. The system as formerly arranged drew large volumes of cold, dry air from outside and blew it hot and very dry into the room. It was, in fact, the most effective kind of a drying plant. The volume and dryness of this air was so great that the humidifiers could not properly cope with the conditions. As a result the humidity was insufficient and very unequal. The heating plant and the humidifiers were working in direct opposition to each other—the one heating, the other cooling—the one moistening, the other drying. Such a mismated arrangement never could be expected to succeed, and it is no wonder that it placed a system, which is superior in every other respect, in disfavor. When operating in connection with a humidifier, however, only sufficient air is taken from outside to create a plenum within the building, and to prevent infiltration of cold, dry air so that a maximum economy in heating is secured, an economy which I am safe in saying is greater than that which can be secured by direct radiation. The air is uniformly humidified before introducing into the room, not afterwards. Thus the humidifying works in conjunction with the heating system and one does not antagonize the other. The circulation produced maintains a uniform degree of humidity in all parts of the room.

This system of humidification may be easily applied to fan systems already installed. However, the size of the fan ordinarily used is insufficient to care for summer conditions and the apparatus can be successfully operated only during cool weather. Old plants, however, can easily be remodeled by the installation of a larger fan and putting in additional ducts.

Another considerable advantage in employing this method of heating is that it avoids a great amount of piping strung along the ceiling, which not only is very inefficient in heating, but catches dust and lint, which eventually drops off and causes inequalities in the yarn.

DIFFICULTIES

That there are engineering difficulties to be met with in the installation of this system of cooling and humidifying is not to be disputed. Somewhat similar systems have been tried and have failed. These failures may be attributed to one or more of the following causes:

1. Humidifier does not sufficiently saturate the air.
2. The temperature and humidity are not properly controlled.
3. Attention is not given to the great amount of heat generated by the machinery and insufficient ventilation is provided to care for same.
4. Takes all air from outside, overlooking the fact that the air if too cold will not hold sufficient moisture.
5. Makes no provision for controlling the temperature of the humidified air.

All of the above difficulties have been carefully taken into consideration and avoided.

DIFFERENT HUMIDITIES

Another apparent obstacle in the way of the successful operation of this system is the obtaining of different humidities in different departments. This difficulty, however, is more apparent than real. The humidity in the room is controlled just as easily as the temperature. The saturation and temperature of the air at the apparatus are controlled from one room, preferably the spinning room, which is the most difficult to care for. Higher humidities are obtained in the winding room and weave room by providing an increased quantity of air in proportion to the horsepower developed, thereby bringing the temperature of the air nearer to the dew point. In the card room, where a lower humidity is desired, the air is shut off until trouble is not experienced by the sliver sticking to the cards. Shutting off the air supply effectually reduces the humidity any desired amount, because, first, it allows a slight temperature rise in the room, and second, the decrease in air volume and pressure allows a correspondingly increased infiltration of dry air. This regulation is easily secured and was originally worked out from a practical standpoint rather than a theoretical. The tests given in the second portion of this paper illustrate this condition.

HORSEPOWER TO MOVE AIR

One objection which may be suggested with reference to this system is the power required to move the large volumes of air necessary for cooling in summer. It is undeniable that considerable power is required in hot weather, when a maximum amount of ventilation is necessary. This is entirely unavoidable beyond the precaution of using large apparatus and large ducts. It is impossible to obtain

something for nothing. It has been shown that it is impossible to move this amount of air by natural means and to remove it by artificial means requires power, whether one type of fan is used or another. In this respect it is well to adhere to the best engineering practice, using a large fan at slow speed and large ducts with small resistance. The amount of power required for ventilation is dependent upon the volume of air, and upon the pressure against which it is moved. The volume of air is dependent upon the horsepower consumed in the mill, and the practicable pressure depends largely on the size and construction of the building. The horsepower for summer ventilation is a direct percentage of the power required to drive the machinery. This percentage will be greater for large mills than for small mills, varying from 5 per cent. in a small building to 10 per cent. in larger buildings where longer ducts and higher velocities must be used. This expenditure of power is unavoidable if a proper cooling effect is to be secured by artificial means. During the winter time the heating plant is operated with only 30 per cent. of the power required in summer. Where motor drive is employed it is usual to operate the fan at three different speeds: the maximum speed for extremely hot weather, a minimum speed for cold weather, and a medium speed for mild weather. In a 10,000 spindle mill, 35 horsepower will be required for the maximum speed, 11 horsepower for the minimum speed, and about 23 horsepower for the medium speed, making an average for the entire year of 23 horsepower for a 10,000 spindle mill, for heating, humidifying and cooling. To offset this, the average output of the mill may be increased fully 5 per cent.

The principal advantages of the system are:

1. Humidifies and cools the air before, not after, entering the room.

2. No dependence on uncertain and insufficient air leakage in and out of the mills for cooling effect.

3. Humidified and cooled air delivered to work rooms under slight pressure and so as to avoid drafts. Inward leakage of hot air in summer and of cold, dry air in winter thereby prevented—an essential feature for uniform humidity and temperature conditions.

4. Cools the rooms without opening the windows in summer, thereby avoiding window drafts—disastrous to fine yarns.

5. The one system cools the spinning room within 5° of outside temperature in summer, insures uniformly heated and regulated temperature in winter, maintains and controls the humidity in all parts of the mill at any desired degree both winter and summer.

6. The apparatus is located centrally, permitting each department to be controlled from one point at the apparatus, or at each room, as preferred. One man can easily care for the entire humidifying, cooling and heating equipment.

7. Working of apparatus always visible; sprays easily accessible; exceedingly

TEST OF HUMIDIFYING SYSTEM AT CHRONICLE MILL, BELMONT, N. C.

	Test No. 1 Dec. 7, 1906.			Test No. 2 Dec. 27, 1906		
	9:30 A. M.	12 M.	3 P. M.	2 P. M.	3 P. M.	4 P.M.
Outside dry bulb temperature	44½°	51°	52°	48°	48°	48°
Outside wet bulb temperature	36°	39½°	40½°	47°	47°	47°
Per cent. humidity outside	40	31	30½	95	95	95
Grains of moisture per cubic foot of outside air	1.33	1.35	1.40	3.6	3.6	3.6
Dry bulb temperature of air leaving humidifier	71°	70½°	70½°	71°	71°	71°
Wet bulb temperature of air leaving humidifier	70°	69¾°	69½°	70°	70°	70°
Per cent. humidity air leaving humidifier	96	97	96	96½	96½	96½
Grains of moisture per cubic foot of air leaving humidifier	7.85	7.75	7.7	7.85	7.85	7.8
Dry bulb temperature, card room	71°	72°	72°	73½°	73°	73°
Dry bulb temperature, spinning room	79°	80½°	81°	80°	79½°	79½°
Dry bulb temperature, winding room	69°	70½°	70½°	71°	71°	71°
Wet bulb temperature, card room	63°	63½°	63½°	65°	65°	65°
Wet bulb temperature, spinning room	72°	72½°	72°	72°	72°	72°
Wet bulb temperature, winding room	66°	67°	67°	68°	67½°	68°
Per cent. humidity, card room	62	61	61½	63	64	68
Per cent. humidity, spinning room	70	69½	69	69	70	70
Per cent. humidity, winding room	84	83	83	87	86	87
Cubic feet of air per minute		25,000			25,000	
H. P. to operate fan and pump		19			19	

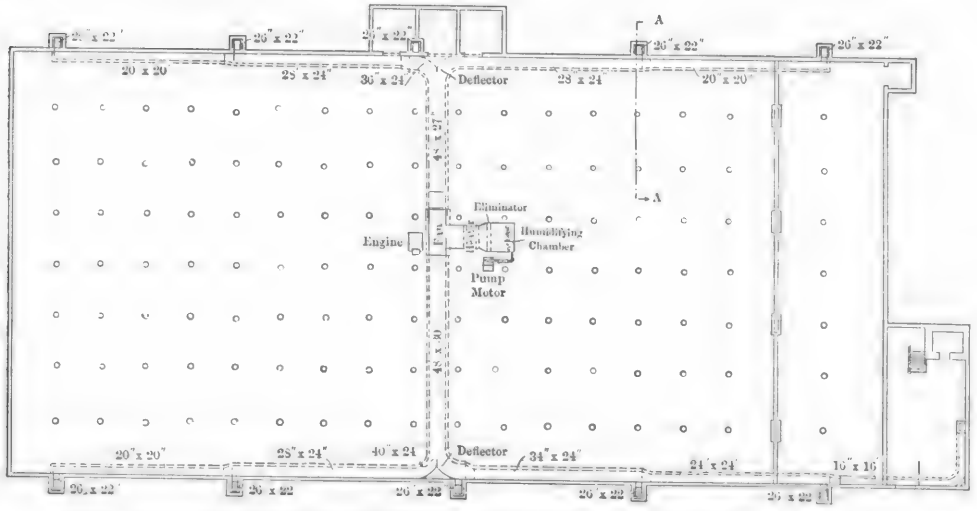


FIG. 4—PLAN OF HEATING, VENTILATING AND HUMIDIFYING PLANT, EAGLE SPINNING CO., HAMILTON, ONT.

simple; nothing to get out of order. Spray water may be easily recirculated without filtering. Requires but little attention.

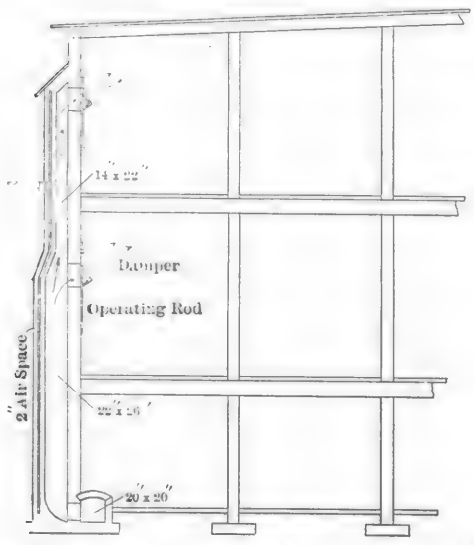


FIG. 5—ELEVATION OF HEATING, VENTILATING AND HUMIDIFYING PLANT, EAGLE SPINNING CO., HAMILTON, ONT.

8. Humidity controlled at any desired per cent. The control is automatic and of great simplicity.

9. Permits large portion of air to be recirculated when heating in winter, thereby effecting great economy.

TESTS OF HUMIDIFYING SYSTEMS

Accompanying are tests made on this system of humidifying and humidity control. The first two tests were made at the Chronicle Mills at Belmont, N. C. This is a two-story, 5,000-spindle mill. On the lower floor is the picker room, the card room and winding room, which is separated from the rest of the building. On the upper floor is the spinning room proper. The cubical contents of each floor is about 170,000 cubic feet. The humidifier was installed in connection with a heating system which was somewhat too small to secure the best results in hot weather. It, however, operates very satisfactorily during the cool, dry weather of fall and winter.

The third test was made at the Eagle Spinning Mill, Hamilton, Ontario. This mill was supplied with new apparatus throughout, the layout for which is shown in Fig. 4. The results of this test were as follows:

	March 4, 1907			
	9 A. M.	12 M.	2 P.M.	4:30 P.M.
Outside dry bulb temperature	29°	35½°	38°	36°
Outside wet bulb temperature	27°	31°	32½°	32°
Per cent. humidity outside	75	61	48	65
Grains of moisture per cubic foot of outside air	1.4	1.5	1.5	1.6
Dry bulb temperature of air leaving humidifier	67°	67½°	67½°	67½°
Wet bulb temperature of air leaving humidifier	66°	66½°	66½°	66½°
Grains of moisture per cubic foot of air leaving humidifier	7.0	7.1	7.1	7.1
Dry bulb temperature, card room	73°	74°	74°	74°
Dry bulb temperature, spinning room	77½°	79°	80°	79°
Wet bulb temperature, card room	64½°	65°	65°	65°
Wet bulb temperature, spinning room	69½°	70½°	71°	70½°
Per cent. humidity, card room	61	60	60	60
Per cent. humidity, spinning room	67½	66	65	66

It is to be noted in the foregoing tests that proper humidity was secured in each of the rooms independently. Both of these mills were operated with automatic regulation for the spinning room, other rooms being controlled by hand regulation.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Entertainment at the Recent Milwaukee Meeting

In addition to the entertainment plans for the heating engineers, as announced, a number of other social pleasures were arranged which filled up every available moment the visiting members and their guests had to spare.

Immediately upon the adjournment of the morning session on Thursday, July 18, the visitors were taken in automobiles to the two plants of the H. W. Johns-Manville Co., where an interesting inspection was made of the processes involved in the manufacture of pipe covering and asbestos materials. Luncheon was served at the company's plant which was greatly enjoyed by the guests.

In the evening, among the dinner parties was one given by Mr. T. J. Waters, president of the Illinois Chapter, the guests being James Mackay, Miss Mackay, William M. Mackay, Frank K. Chew, James M. Stannard, Mrs. Waters, Miss Waters, Master Waters and Miss Boylston.

Friday morning, after the close of the morning session, a large party walked over to the plant of the Johnson Service Company, which is but a block from the hotel, and after being shown through the various departments engaged in the manufacture of temperature-controlling apparatus, sat down to an appetizing luncheon as guests of the company.

During the afternoon session, on the same day, the ladies went on a sightseeing trip to some of Milwaukee's public buildings.

Following the final adjournments on Friday, the entire party, including the ladies, started in tally-ho coaches for White Fish Bay to partake of a course dinner at the lake shore. The menu was artistically printed as a souvenir of the occasion and contained pictures illustrating some of the city's manufactures.

President Snyder was toastmaster. The list of toasts were well framed and were ably responded to by all the speakers.

Professor John R. Allen rose to speak on "The Making of an Engineer,' in which he pleaded for more encouragement and help for the young engineer. Secretary William M. Mackay said a word for "Our Society." Professor J. H. Kinealy spoke for "Our Hosts." Professor Warren S. Johnson described "The Important Factor in Our Life Work." Mrs. W. S. Halsey, in virtue of her position as wife of a vice-president of the National Plumbers' Association, was called on for a word of greeting to the ladies, in which she acquitted herself with much credit. John F. Hale responded to the toast, "The Chapter and Its Influence." F. F. McNichol was called on to speak for "Our Guests." Frank K. Chew told "How Our Work is Made Valuable." He went on to say that he himself and other editors whom he named, were glad to present in their papers the experiences so freely given by the members. He omitted to mention the editor of THE HEATING AND VENTILATING MAGAZINE, but never mind. Our readers know the policy of this journal too well to need any such assurance from us. James A. Donnelly responded to the last toast of the evening, "The Summer Meeting."

The following ladies attended the meeting: Mrs. C. B. J. Snyder, New York; Mrs. T. J. Waters, Miss Waters, Miss Boylston, Miss Mackay, Mrs. J. H. Davis, Mrs. Howard A. Moss and Mrs. John K. Allen, Chicago; Miss Arabella Kauffman, St. Louis; Mrs. Anderson, South Bend, Ind.; Mrs. E. J. Ryan and Miss Ryan, Danville, Ill.; Mrs. John R. Allen, Ann Arbor, Mich.; Mrs. W. S. Patterson, Appleton, Wis.; Mrs. Johnson, Mrs. W. K. Downey, Mrs. John S. Brennan; and Mrs. W. H. Halsey, Milwaukee.

Notes

James Mackay entertained several members of the Board of Governors and others at dinner at the Chicago Athletic Club the evening before the opening of the meeting. The guests were President C. B. J. Snyder, Mrs. Snyder, Mrs. James Mackay, Miss Mackay, Secretary W. M. Mackay, Frank N. Chew.

A good-sized party took the trip from Chicago to Milwaukee by water. A meeting of the Board of Governors was held on the boat.

Prudential Heater Co., Akron, O., was responsible for the little pocket wrenches that were handed around by A. G. Cripps.

Massachusetts Association of Heating and Ventilating Engineers

A delightful outing of the Massachusetts Association of Heating and Ventilating Engineers and Contractors, whose membership consists of nearly all the master steam fitters of Boston and vicinity, took place July 23 at the Relay House, Bass Point, Nahant, Mass.

The steamboat, "General Lincoln," carried the party to Bass Point and the sail down Boston Harbor and return was much enjoyed by all.

A fish dinner, of the kind that make the various shore resorts around Boston famous, was served and speeches were made by President Charles H. Sanborn, Hon. Paul H. Kendricken, Arthur C. Walworth and Albert B. Franklin.

It was agreed by all that the outing was a most enjoyable one, and a vote of thanks was tendered to President Sanborn for his efforts in making the affair such a success.

Chicago Association of Master Steam Fitters

The annual meeting of the Chicago Steam Fitters' Association, which is a local body, not affiliated with any other organization of master steam fitters, was held June 25 last. The following officers were re-elected: President, George Mehring; vice-president, William L. Kroeschell; treasurer, William A. Pope; secretary, John J. Spear; directors to serve for the ensuing year: George Mehring, F. W. Lamb and Thomas J. Douglass. The meeting closed with a banquet, at which Secretary John J. Spear was presented with a handsome diamond ring by his associates as a token of their appreciation of his loyal services.

Add Correspondence

Trade Literature

Webster Grease and Oil Trap, for use in connection with oil separators and feed-water heaters, is illustrated and described in a leaflet issued by the manufacturers, Warren Webster & Co., Camden, N. J. This trap does away with the vented seal and other means of draining oil separators. It is made up of two flanged castings, one of which contains the inlet and outlet posts and the valve mechanism, with the ball float. The other casting acts as a cover for the trap and has a hand-hole covering directly over the valve. The trap operates by means of a spherical copper float. It is made in all standard pipe sizes from ¾ inch to 2½ inch, inclusive.

The notable success of the Webster specialties may be judged by the fact that there are over 3,000 installations of the Webster system of steam circulation, 3,500 installations of the Webster feed-water heaters and purifiers, amounting to over 2,000,000 horsepower, and over 10,000 installations of the Webster steam and oil separators.

A. A. Griffing Iron Co., Jersey City, N. J., in a newly issued circular, notes the superior points of the Bundy tubular and the Bundy La Flora steam boilers for hard coal, and the Bundy La Flora boilers for steam and hot water, burning soft coal.

Utility Steam Specialties are graphically described in a new catalogue issued by the Standard Steam Specialty Co., New York, the illustrations including over a score of detail sketches, showing the dimensions and application of the company's large line of specialties, including the utility exhaust muffler, oil separator, return tank and pump governor. The catalogue is arranged for easy reference on the draughting board, the even pages being left blank, while all of the necessary information regarding each apparatus is contained in a table directly beneath the sketch. Pp. 52. Size, 5x10 inches.

Manhattan Boilers and Radiators, the new line recently placed on the market by the Mackay Mfg. Co., 113 Beekman street, New York, are now ready for the trade. The round boilers are made with 19-, 22-, 25- and 28-inch grates, while the line of vertical boilers range in size from 18-inch to 48-inch grates.

In addition the Manhattan line of radiators, the company is making a full line of radiators, known as the Knickerbocker. The firm is also handling the Knickerbocker hot-air furnace and combination hot-air and hot-water heater, the Mackay hot-water valve, the "W. M. Mackay" air valve and other heating specialties.

Positive Differential System of Steam Circulation is the title of a catalogue issued by James A. Donnelly, New York, containing a recently prepared description of this system of vacuum steam heating. A number of illustrations and tables accompany the text, supplementing the description of the system and its method of operation.

Holland Heating Manual, published by the Holland Radiator Co., Chicago, Ill., is a new catalogue designed for the use of those specifying as well as those installing radiators and boilers. Included in the catalogue are prices of heating specialties and other useful information, in addition to full descriptions with lists of sizes of the Holland boilers and radiators. Pp. 132. Size, 4½x7¼ inches.

Armour Heating Co., Roanoke, Mo., heating large hotel on Broadway, Kansas City, for Mrs. Mary McClintock, of that city.

Jennison Plumbing Co., Fitchburg, Mass., heating and ventilating and plumbing new schoolhouse at Athol.

J. C. Sullivan, Mason City, Iowa, heating and ventilating new courthouse.

Allen Black Co., St. Paul, Minn., heating Government buildings at Fort Snelling, Minn.

Wyckoff & Lloyd Co., Springfield, Mass., heating and ventilating Renfrew School building in Adams, Mass.

TRADE AND MISCELLANEOUS NOTES

Deaths

Thomas H. Capp, president of the Union Boiler Manufacturing Co., Lebanon, Pa., is dead at his home at Jonestown, Pa.

Daniel Markle, a member of the firm of Burry & Markle, Evans City, Pa., hardware dealers and heating and plumbing contractors, died recently at his home in Evans City. He was 53 years old.

William J. Jarvis, one of the founders and formerly treasurer of the American Radiator Co., died in his forty-eighth year, at his home in Detroit, Mich., of appendicitis. Mr. Jarvis was for many years engaged in the pig iron business in Detroit, being the senior member of the firm of William J. Jarvis & Co.

Moses P. Breckenridge, former superintendent for the H. B. Smith Co., Wetsfield, Mass., manufacturers of boilers and radiators, died at the age of 76 years. At the time of his retirement, in 1905, he had been connected with the H. B. Smith Co. 36 years.

Miscellaneous Notes

Cooper Heater Co., Dayton, O., has acquired the large North Dayton plant, formerly occupied by the Craig-Reynolds Co., including the machinery and other equipment. The purchase price of the plant and equipment is understood to have been $200,000.

Andrew Ashton, Rockford, Ill., will build a heating plant in Rockford to furnish steam to the Ashton Block. The plant will be located on Church street.

Dean Heat Distributor Co., Allentown, Pa., is accused, in a creditors' petition for a receiver, of wrecking its business in part by the use of "Gibson girls" to exploit its business. The girls were employed to show by their beautiful appearance that the company's ranges would not spoil the fairest complexion.

Taylorville Utility Co., Springfield, Ill., will build an electric light, heating and ice plant this fall. The plant will cost $125,000, and contracts to the amount of over $80,000 have already been let.

Des Moines Heating Co., and the Iowa Light, Heat & Power Co., Des Moines, Ia., have transferred their franchises to W. D. Kinnick, in consideration of the payment of $5 and certain claims which are liens against the franchises. J. S. Polk and G. B. Hippee are the principal stockholders in the two companies.

United Bunch of Sheep, composed of heating and plumbing salesmen operating in Wisconsin and the northern part of Michigan, was formally organized Aug. 2 last in Milwaukee. Following are the officers, as announced: Grand ram, G. B. Carr; vice-ram, Frank Young; chief shearer, C. R. Seager; guardian of the golden fleece, James Ketcham; bell sheep, E. A. Savage; assistant chief shearer, John Carroll; shepherd of the flock (chaplain), George McCarthy; keeper of the fold, Frank Nolan; herder, Max D. Rose; trustees, Joseph L. Kaestle, Arthur Wellhousen and David Johnson. The main office of the organization is at 214 Sycamore street, Milwaukee, and is known as the "Home Fold."

National Association of Plumbers has moved its executive quarters to New York, as a result of the election as president of that body of Thomas A. Hill, of New York. W. Emmet Crosby, the executive clerk of the association, is now

CLASS A RETURN TRAP

THE ALBANY RETURN STEAM TRAPS

Have been the standard for over thirty-two years. For returning water under pressure to the boiler they will perform this duty fully as well and in many cases better than the so-called steam loop.

SEND FOR CIRCULARS A. B. C. AND D.

CLASS D TRAP HIGH PRESSURE

MANUFACTURED BY

ALBANY STEAM TRAP CO., ALBANY, N. Y.

ESTABLISHED 1870

JAMES H. BLESSING, Pres. THOMAS F. RYAN, Treas.

located in the association's new quarters in the Childs Building, at 110 West Thirty-fourth street.

James H. Davis, until now manager of the American Engineering Specialty Co., Chicago, Ill., representing Warren Webster & Co., of Camden, N. J., has associated himself with the American Radiator Co., Chicago.

Central Heating Co., Milwaukee, Wis., has been assessed $300,000 on its plant and underground tunnels.

Des Moines, Ia.—A movement is on foot, headed by F. E. Stott, a heating engineer, to purchase the franchise of the defunct North Des Moines heating plant and of the Des Moines Heating Co., with a view of consolidating the plants throughout the city and operating them upon a much larger scale.

Manufacturers' Notes

American Steam Pump Co., Battle Creek, Mich., is building a two-story addition to its plant to be devoted to a testing room, paint shop and shipping and storage warehouse.

Abendroth Bros., New York, has made extensive alterations in its new showrooms at Beekman and Pearl streets, New York, where a complete line of the company's line of heating apparatus is now shown.

Cleveland Castings Pattern Co., Cleveland, O., has succeeded to the business of the Gobeille Pattern Co. The new company's officers are: President, F. W. Wood; vice-president, A. K. Spencer; secretary and treasurer, D. G. Miller; superintendent, V. G. Farner.

Ruud Manufacturing Co., Pittsburg, Pa., is equipping a new plant in Toronto, Can., for the manufacture of its product, including instantaneous water heaters and storage heating systems. George Hobbs, general manager of the company, will have charge of the new plant.

Magee Furnace Co., Boston, Mass., has recently made a notable shipment of heating apparatus to the Pacific coast, by way of Cape Horn. The cargo is said to weigh over 1,000,000 pounds.

Van Auken Motor & Machine Works, Bridgeport, Conn., has succeeded to the business of the Van Auken-Clevaue Company and has moved the company's offices and works to Bridgeport. The officers are: President, Henry Adams, Jr.; vice-president, Chauncey Marshall; J. T. Brown, treasurer.

J. R. Brockman Manufacturing Co., St. Louis, Mo., has taken over the business of Miller & Brockman, dealers in steam fitting supplies. President and treasurer, J. R. Brockman.

Worden Tool Co., Cleveland, O., has increased its capital stock from $30,000 to $60,000. The company has recently built a new plant.

American Manufacturing & Heating Co., manufacturers of furnaces for gas, coal and coke, is arranging to establish a plant at Parkersburg, Tenn.

Erie Heating Co., Chicago, Ill., dealers in mill supplies, will move to Rockford, Ill., maintaining a branch office at Chicago.

Sirocco Engineering Co., New York, manufacturers of the Sirocco fans and blowers, has obtained a plant at Green Island, Troy, N. Y., which is being overhauled and refitted for the company's use. The Sirocco fans have in the past been imported from the Sirocco Engineering Works, Belfast, Ireland, and set up on this side.

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Borden Co., Warren, O., manufacturers of pipe threading machines, has moved into its new plant at Warren. The plant consists of a main building 80x200 feet, and an adjoining building 30x140 feet.

General Electric Co., Schenectady, N. Y., will build a plant at Erie, Pa., for the manufacture of heavy iron work, to employ between 5,000 and 7,000 men. A site has been secured consisting of 800 acres.

New Incorporations

Dickey & Morgan Heating & Plumbing Co., El Paso, Tex., capital $30,000. Incorporators: R. D. Dickey, Thomas J. Morgan, A. J. Carpenter, T. C. Lea and S. E. Porter.

H. J. Brandeles Co., Utica, N. Y., capital $5,000, to conduct a heating and plumbing business. Incorporators: H. J. Brandeles, George D. Mason and William Simmons.

Huey Brothers Co., Boston, Mass., capital $100,000, to take over the plumbing and heating business of Huey Brothers. Incorporators: David S. Huey, Thomas J. Huey and John C. Harrington.

Eureka Valve Co., Boston, Mass., capital $50,000, engaged in the manufacture of plumbing specialties. Incorporators: Charles E. Chester, Francis T. Cagnay and George J. Thomas.

Superior Oil Cup Co., New York, capital $50,000, to manufacture oil cups, etc. Incorporators: Irving S. Van Loon, William Phipps and Zela A. Van Loon, all of New York.

Phoenix Tool & Valve Co., San Francisco, Cal., machinists' supplies and tools. President, W. D. Caldwell; vice-president, F. C. Logan; secretary-treasurer, H. Pierce.

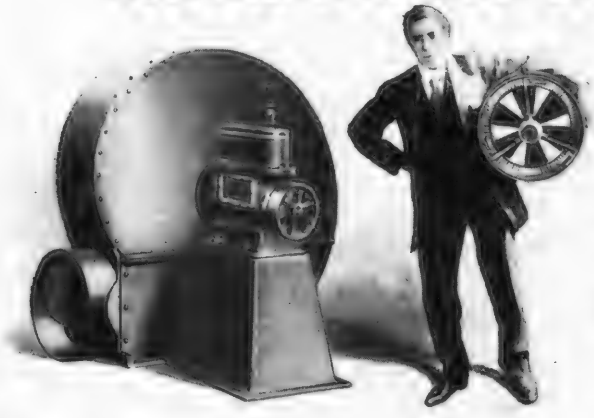
Middleboro Plumbing & Heating Co., Frankfort, Ky., capital $30,000. Incorporators: W. A. Liebig, S. M. Liebig and A. P. Liebig.

Central Heating & Power Co., Des Moines, Ia., capital $70,000. Incorporators: W. B. Starkey, M. O. Payne and W. H. Shott.

Ellwood Malleable Co., Pittsburg, Pa., with a capital of $250,000, to operate bronze and brass foundries. Incorporators: Frank E. Dambach, James R. Hughes, H. W. Dambach, K. J. Kendricks, W. J. McKey, of Elwood City, Pa., and Ira W. Logan, of Pittsburgh.

Gschwind Furnace Co., Youngstown, O., capital $25,000, to manufacture heaters and furnaces. The company has secured temporary quarters for its plant at Salem, O., but will locate permanently at Youngstown. Incorporators: Leon Gschwind, Carl K. Schwind, William E. Rantz, W. R. Leonard and I. K. Inglefritz, all of Youngstown.

WING'S TURBINE FAN SYSTEM OF MECHANICAL DRAFT



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means guaranteed economy of fuel, increased boiler capacity, absolute simplicity.

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West and Cedar Sts.
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Mfrs. Wing's Disc Fans, Blowers and Exhaust Fans

Designers and Builders of Heating and Ventilating Systems

Kinney Manufacturing Co., Boston, Mass., capital $1,000,000, to manufacture machinery and engines. President and treasurer, J. R. Kinney.

Wolfe Machine Co., Buffalo, N. Y., capital $45,000, to manufacture machines and machinery. Incorporators: Clinton R. Wyckoff, Arthur P. Wolfe and John M. Salterfield, all of Buffalo.

Atlantic Machinery Ca., Boston, Mass., capital $20,000, to manufacture machinery. President, Joseph H. Crogan; secretary-treasurer, H. S. Crombie.

Charles L. Crabb Co., Queens, N. Y., capital $10,000, to manufacture machinery and tools. Incorporators: Louis Berger, Carl Berger and Charles L. Crabb.

Des Moines Central Heating & Power Co., Des Moines, Ia., capital $10,000.

Boynton Company, Waterloo, Ia., capital $100,000, to manufacture furnaces, blowers and pumps. President, J. F. Boynton, vice-president; M. E. Boynton; secretary and treasurer, M. J. Krezek.

St. Johns Heater Co., St. Johns, Mich., capital $10,000, to manufacture heaters. Incorporators: Seymour D. Watson, Horace B. Kneeland, Horace S. Hilmes, Louis B. Richmond and F. C. Mason.

Model Plumbing & Heating Co., Beaumont, Tex. Capital $20,000.

H. P. Cahill Plumbing Co., Akron, O. Capital $20,000. Incorporators: H. P. Cahill, Louisa M. Cahill, John E. Stehl, Frank J. Schermesser and Walter H. Cahill.

C. A. Stacy Co., Oxford, N. C. Capital $50,000. Incorporators: C. A. Stacy, W. H. Hunt and S. W. Parker.

Capell Fan & Engineering Co., Pittsburg, Pa., manufacturing centrifugal fans and pumps, boilers, engines, etc. Incorporators: Wilson A. Luce, Abbott S. Cooke, Walker J. Wilson and John O. Petty, all of Pittsburg.

Damrow Bros., Fond du Lac, Wis., Capital $25,000, to conduct a heating and plumbing business. Incorporators: George H. Damrow, E. C. Damrow, Walter Damrow and Otto A. Basseuner.

Pettit & Baird, Little Rock, Ark., heating contractors. Capital $10,000. President, E. N. Pettit; vice-president, Robert Kirkwood; secretary and treasurer, James H. Baird.

Hill Car Ventilating Co., Washington, D. C., capital $500 000, to acquire the title and patents issued to David Hill on apparatus for the ventilation of railroad cars. Among those interested are David Hill, James S. Hill, W. T. Hudnell and J. B. Whire Whitehurst.

Taylorville Utility Co., Springfield, Ill., capital nominal, to be increased later to $500,000, to manufacture light, heat and power.

Zinc-Coated Steel Slip Nipples

For Steam and Hot Water Radiators and House Heating Boilers

THE PRATT CHUCK CO., Frankfort, N.Y.

FREE SAMPLES furnished to interested parties

Business Troubles

W. R. Coyne, of the Coyne Trade School, Twenty-fourth street and Tenth avenue, New York, has had a petition in bankruptcy filed against him by Otto Bernz, of Newark, N. J., for $2,286, for goods sold to him. Mr. Coyne is now in St. Louis. The trade school in New York was established about two years ago. It is said that Coyne sold the business to Alfred J. Swift, on April 16, for $40,000, and that notes received in payment were transferred to various creditors.

New Firms

Reading Supply & Construction Co., Reading, Pa., is a new heating and ventilating contracting firm, with offices and supply warehouse at 417-421 North Tenth street. President F. F. Galvin, formerly contracting engineer with the Buffalo Forge Co.; treasurer, J. A. Martin.

Charles Plumbing Co., Wilkinsburg, Pa., heating and plumbing, composed of Charles Appelgarth and Charles Mielcke.

Becker-Seidel Co., Cleveland, O., heating and ventilating contractors, at 317 Champlain avenue, N. W. Mr. Becker was for 25 years connected with the firm of Chafer & Becker, of Cleveland.

Cooper Bros., Springfield, Mo., have taken over the business of the Peterson & Brechtel Plumbing Co., of that place.

Jacksonville Plumbing & Heating Co., Jacksonville, Ill., heating and plumbing contractors at 230 East Court street. The members of the firm are George E. Belzer and Spencer Taylor.

McKinney & Co., Galesburg, Ill., is the changed title of the firm of James A. McKinney, C. R. Bradshaw of that place having purchased a half interest in the business.

Business Chances

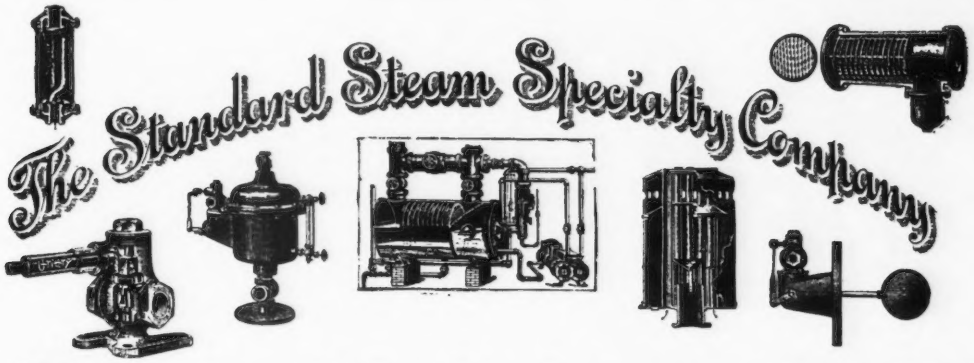
Ann Arbor, Mich.—A new heating and ventilating plant will be installed in the Methodist Church at this place.

Ilion, N. Y.,—The trustees of School District No. 1, at a meeting July 11, appropriated $3,000 for a heating plant for the new school building, to cost $18,000.

Crookston, Minn.—Architect Strassburger has recently drawn plans for the heating and ventilating systems for the Washington School House.

Lansing, Mich.—The committee on parks and public buildings has been instructed to prepare plans and specifications for repairs to the heating plant in the city hall.

Oakland, Cal.—Plans are now ready for the new $2,000,000 Bankers' Hotel, to occupy the block at Thirteenth, Fourteenth, Harrison and Alice streets.



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Webster City, Ia.—As a result of the school board's failure to make satisfactory arrangements with the city to furnish steam heat for the central school buildings, the board has decided to erect a plant to furnish its own steam for heating purposes.

Ishpeming, Mich.—The State legislature has appropriated $43,000 for a new central school heating plant for the Michigan College of Mines at Houghton.

Guthrie, Okla.—Bids will be received by the Board of County Commissioners of Logan County up to Sept. 2, 1907, for the installation of a complete steam heating plant for the new county building of Logan County. Plans and specifications are on file with the county clerk of Logan County, Guthrie, Okla.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 16, 1907, for the construction (except elevators) of the U. S. Marine Hospital, at Pittsburg, Pa.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 16, 1907, for the construction (except elevators) of the U. S. Marine Hospital, at Buffalo, N. Y.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 23, 1907, for the construction (except elevator) of an extention, remodeling, etc., to the U. S. Post Office and Court House at Cedar Rapids, Iowa.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 19, 1907, for the construction complete of the U. S. Post Office at Muscatine, Iowa.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., August 27, 1907, for the construction (including heating apparatus, electric wiring and conduits) of the extension to the U. S. Post Office and Court House at Trenton, N. J.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 4, 1907, for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. Post Office and Custom House at Quincy, Mass.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., September 3, 1907, for the construction (complete) of the U. S. Post Office at Watertown, N. Y.

Contracts Awarded

George Huey, Springfield, Mass., heating and ventilating ten-room addition to Chestnut Street School; also heating and ventilating new high school at Revere.

Halverson Bros., Ogden, Utah, heating State Deaf and Blind School for $4,900.

Ben F. Barbour Plumbing Co., Birmingham, Ala., heating and ventilating plant for the Paul Hayne School, to cost $3,500.

P. J. Killeen & Co., Dundee, Ill., heating and plumbing new city hall at Algonquin.

Warren Machine Co., Crookston, Minn., heating and plumbing new Marshall County jail and sheriff's residence at Warren, at its bid of $2,700.

Burns Bros., Bloomington, Ill., steam heating system for school building, in Chatsworth, to cost $1,575.

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ADDRESS

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Chafer Co., Cleveland, Ohio, heating two-story brick building, containing four stores on Euclid avenue for the Boardman Co.

Kidder Machine Co., Franklin, N. H., steam heating and automatic sprinkler system for the Hemphill Mfg. Co.'s plant at Pawtucket.

Fargo Plumbing and Heating Co., Fargo, N. D., heating and ventilating plant for the high school building in Fargo. The Van Auken system will be used. The contract amounts to $7,990.

Martin Anderson Co., Bridgeton, N. J., hot-water heating Monroe Street school at Bridgeton.

Ed. Downing, Decatur, Ill., heating plant for the St. Nicholas Hotel, at Decatur, to cost $2,500.

Newton & Zimmerman, Beloit, Wis., heating and plumbing new jail building for $1,022.

Louis C. Bartholomew, Michigan City, Ind., heating Garfield school.

B. O. Paulsness, Grand Forks, N. D., heating and plumbing new fire house for $1,725.

John H. Gludt, Lake City, Minn., steam heating new school building at Maiden Rock, Wis.

Barkley, Boughton & Crain, Ft. Collins, Col., heating new Franklin school building.

Michigan Power Co., Lansing, Mich., heating plant for State Capitol Building.

G. H. Hershey & Son, Lambertville, N. J., heating plant for Methodist Church.

M. B. Crawford, Oswego, N. Y., heating new hospital building.

W. Morgan, San Francisco, Cal., heating El Dorado school at Stockton.

De Hart & Stoeckel, Davenport, Ia., heating and plumbing new bank building.

E. D. Bartholomew, Mauch Chunk, Pa., heating T. H. Griffith's store building at Nesquehoning, Pa.

Eschle Plumbing Co., Butte, Mont., heating and plumbing new industrial school building at Butte for $14,788.

Columbus Heating & Ventilating Co., Columbus, Ohio, heating and ventilating high school building at Cameron, W. Va.

F. & W. V. Engelberger Co., Newark, N. J., heating school building at Irvington for $2,699.

Iron City Heating Co., Pittsburg, steam heating the new St. Francis Hospital in Lawrenceville. The contract amounts to $54,500.

Fuller & Warren Co., Boston, Mass., heating schoolhouse at Auburn, R. I.

C. F. Brennan, Crookston, Mass., heating the Washington School at Crookston, for $1,250.

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is the most simple and effective of any on the market.
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J. J. Carney, Adams, Mass., heating Police Station at Adams.

Otto A. Wurm, Detroit, Mich., plumbing and heating the addition to the Plymouth High School, at Plymouth, Mich. Also heating and ventilating the Fanny E. Wingert School, and the Newberry School.

W. H. Long, Huntington, Pa., heating and plumbing Leister House.

Electrical Construction and Supply Co., Columbus, O., plumbing, heating and electric wiring the new Franklin County Court House in that city.

Sewickley Plumbing & Heating Co., Sewickley, Pa., heating and plumbing large apartment building.

F. C. Bartley Heating Co., Wilkinsburg, Pa., steam heating addition to new school building at Duquesne, Pa.

Parkersburg Supply & Plumbing Co., Parkersburg, W. Va., laying high pressure pipe line through yards of Baltimore & Ohio Railroad. The work will cost $7,500.

Gray & Sutter, Fulton, Mo., heating and plumbing the gymnasium and music conservatories for Stevens College, at Columbia, Mo.

J. B. Hughes Heating Co., St Louis, Mo., hot water heating a $12,000 residence on Upper Park avenue.

B. C. Adams, Decatur, Ill., steam heating and plumbing two-story dormitory in that city, for the James Milliken College. Also steam heating and plumbing school building.

Lane & McNally, Moberly, Mo., steam heating and plumbing $20,000 office building at 500 Broadway.

Elliott & Barry Engineering Co., St. Louis, Mo., steam heating $100,000 apartment building at West Pine Boulevard and Sarah street for F. A. Banister.

Davidson & Roster Plumbing Co., St. Joseph, Mo., heating and plumbing mercantile building at Sixth and Felix streets for Block Bros. The contract will amount to $8,500.

John P. Schaffer, Pittsburg, Pa., heating $60,000 apartment building at Oakland for Grault & Giffen.

Newton Dry Kiln Co., Chicago, Ill., steam fitting and iron work in new dry kiln system for the Cove Furniture Co., at Stevens Point, Wis.

Ipskin Bros., Wabash, Ind., steam heating Idaville School at Wabash, for $1,248.

C. F. Bullwinkel, Jefferson, Wis., heating East Side City School, at its bid of $997.97.

National Blower Works, Milwaukee, Wis., heating and ventilating Marathon County Home at Wausau, Wis. The contract amounts to $3,950.

Long-Lewis Hardware Co., Birmingham, Ala., heating the First Baptist church for $1,600.

United States Cast-Iron Pipe & Foundry Co., Pittsburg, Pa., furnishing 1,400 tons of cast-iron pipe, ranging from 3 to 48 inches, to city of Cleveland, Ohio.

West Virginia Heating & Plumbing Co., Charleston, W. Va., plumbing and heating for the Lang residence in that city.

Hoffman-Conklin Co., Columbus, Ohio, steam heating eight-story bank and office building on Federal street, Allegheny, for Savings & Trust Co., of that city.

Anderson-Darragh Co., Pittsburg, Pa., heating $125,000 Hospital for the Insane, at Woodville, Pa.

Pittsburg Heating Co., Pittsburg, Pa., heating $20,000 Snyder residence at Sewickley, Pa.

Ulrich Stewart Co., Allegheny, Pa., heating five apartment houses on Beech avenue, that city.

M. D. McCarthy, Elwood City, Pa., plumbing and hot-water heating for a large store and apartment building in that city.

N. J. Smith, Worcester, Mass., new steam heating system for the Grafton Street School.

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600 CHURCHES AND SCHOOLS
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